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PHOTOGRAPHS AND DESCRIPTIONS OF CUP-FUNGI—XXII. DASYSCYPHA¹

FRED J. SEAVER

(WITH 1 FIGURE)

The writer has recently received from Dr. H. S. Jackson a species of the above genus collected by Dr. Roy F. Cain which is of more than usual interest. The name *Dasyscypha* is here used in a broad sense, including both *Lachnum* and *Dasyscypha*, which, in the opinion of the writer, cannot be satisfactorily separated on the character of the paraphyses as is sometimes done.

The specimen referred to has been determined by the writer as *Dasyscypha crucifera* (Phill.) Sacc. The only other specimen of this species seen is in the herbarium of The New York Botanical Garden (Phillips, *Elvellacei Britannici 162*), together with illustrations of Phillips' material made by George Massee.

When the Canadian material was first examined it was thought to be *Dasyscypha nivea* (Hedw.) Sacc., which, in the opinion of the writer, is synonymous with *Dasyscypha virginea* (Batsch) Fuckel. The presence of minute granules on the outside of the apothecia, however, was puzzling. It was finally decided that it was *Dasyscypha crucifera* (Phill.) Sacc. In checking the matter the writer was interested in the differences of opinion, between M. C.

¹ This paper is preliminary to a monograph of North American Cup-fungi (inoperculates), a companion volume to North American Cup-fungi (operculates), which was published by the author and issued in December, 1928.

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Cooke and William Phillips, on the validity of this character. It is thought worth while to quote these opinions. The writer is inclined to accept Phillips' interpretation, in view of recent observations.

COOKE'S CRITICISM

From The Gardeners' Chronicle II. 10: 442. 1878. "*Peziza crucifera*, Phil.—I quite agree with Mr. Phillips that the crystals surmounting the hairs in this species is an interesting phenomenon, but nothing more. If he has satisfied himself that they are inorganic crystals, then they are not permanent characters, and unless other and distinctive characters can be found the species is a false one. The name *crucifera* is unfortunate, because the crosses on the hairs are no essential parts of the plant. Manifestly, if crystals of oxalate of lime, or crystals of a similar character, were found upon the hymenium of *Peziza aurantia*, Mr. Phillips would not regard it as a distinct species on that account. It is so seldom that my friend Phillips differs from me on essential points, and we are most constantly in correspondence, that I am disposed to regret that we did not discuss this subject previous to the publication of the name. Some time since, when we had this *Peziza* under review, the inorganic character of the crosses had not been mooted; the determination of this point now places the whole question upon a different basis. Probably, as I suggested twelve months since, the crystals which surmount the hairs of *Peziza echinulata*, Awd., are also inorganic, and, if so, must have no place in a specific diagnosis. I was led to the conclusion that this was the case in *P. echinulata*, because, on examining a specimen mounted in glycerine, after twelve months' rest, I could find no trace of the terminal stellata appendages. On remarking upon this circumstance at the time, it was objected that glycerine would in time render these delicate crests so transparent that they would not be recognisable. I have also a memorandum to the effect that similar crystals had been detected on the hairs of fresh specimens of two other foliicolous species on which they are not usually found. I have used the term 'crystals' in all these instances because they most resemble crystals in form. Moreover, I feel strongly impressed with the suspicion of their being 'crystals' in fact, in all these cases, and that they must be left

entirely out of account as specific characters. If there are no features but the stellate apices of the hairs to distinguish *P. crucifera* from *P. virginea*, I must in candour decline to accept *Peziza crucifera* as a distinct species." M. C. Cooke.

PHILLIPS' ANSWER

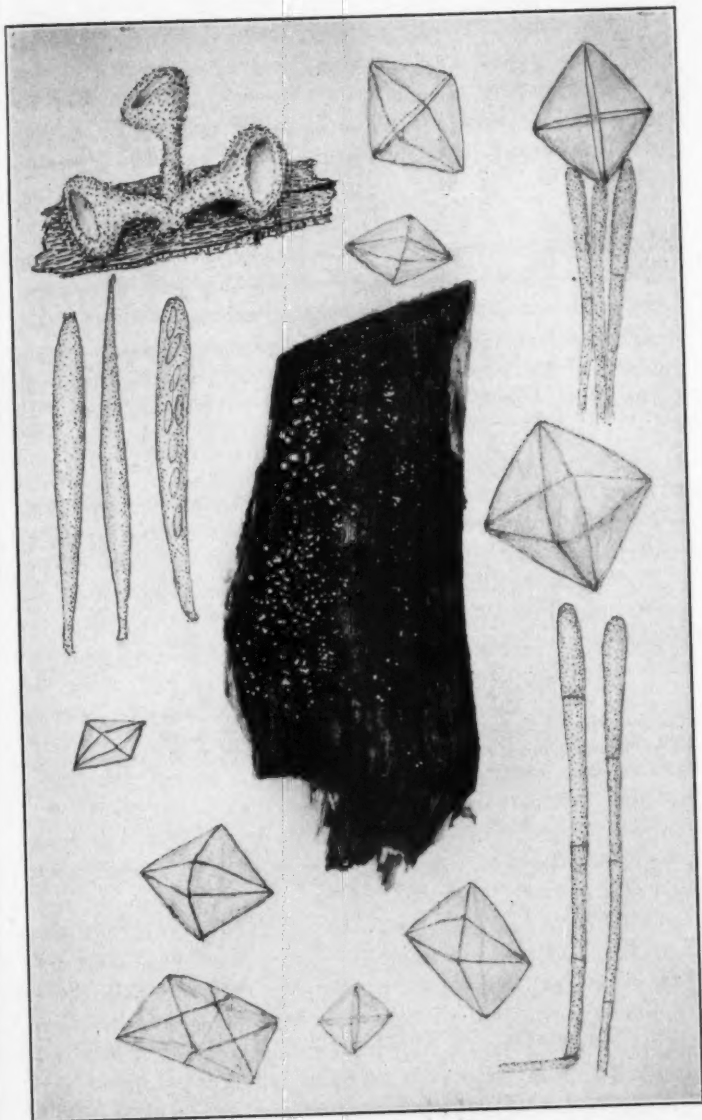
From The Gardeners' Chronicle II. 10: 473. 1878. "*Peziza crucifera* (Phillips).—Dr. Cooke considers (p. 442 ante) the name I have given to this little species 'unfortunate, because the crosses on the hairs are no essential part of the plant.' I would say in reply to this objection that the name expresses a character which, as far as our knowledge goes, is invariably present, and is directly traceable to a function of the plant. Even if the crosses resulted from some source foreign to the plant, still being always found in the curious position they occupy, the name would be as allowable as many others given and accepted by mycologists, and even by my friend Dr. Cooke himself. It is highly probable, if not certain, that these crosses, or more properly crystals, result from a fluid excreted from the terminal cell of each hair, which, collecting in a globule on the exterior, deposits a single crystal of oxalate of lime. At the recent meeting of mycologists at Hereford I offered this as a reasonable explanation of the phenomenon, and further said that I had noticed transparent granular masses of matter occupying a similar position in the following species: *Peziza solfatera*, Cooke and Ellis; *P. epixantha*, Cooke; *P. papillaris*, Sow.; *P. clandestina*, Bull; *P. Schweinizii*, Awd.; *P. palearum*, Des.; *P. latebricola* (Rehm); *P. rosea* (Rehm); *P. brunneola*, Desm.; *P. echinulata*, Awd.; *P. patula*, Pers.; *P. barbata*, Kunz; *P. Spiraea[e]*, Schw.; *P. pellita*, Pers.; *P. marginata*, Cooke; *P. scabrovillosa*, Phillips; and a species unnamed in Mr. Berkeley's herbarium from the Nilgherries. These masses of granular matter have been for some time known to exist on the points of the hairs of several species, but no satisfactory explanation has ever been offered of their nature. The definite crystals on *Peziza crucifera* throw a new light on them, and point clearly to the fact that they also are amorphous masses of probably carbonate or oxalate of lime. The most formidable objection offered by Dr. Cooke is not that to the appropriateness of the name, which

I think is sufficiently answered above, and may therefore be dismissed, but to the validity of the species, unless some other characters than this one can be pointed to as distinguishing it from *Peziza virginea*. This is undoubtedly a very serious objection, unless it can be fairly met. Having drawn up my diagnosis previous to being made aware by Mr. Berkeley of the nature of the crystals, I may have relied too much on their presence and omitted other essential characters. That it is not the same species as *P. virginea*, however, will be seen at once by comparing Dr. Cooke's own figure of that species in Grevillea (vol. iv., tab. 51, fig. 272) with my figure of *P. crucifera* in the Gardeners' Chronicle, p. 397. The hairs of *P. virginea* are there represented as non-septate, cylindrical hairs, whereas in *P. crucifera* they are distinctly septate and enlarged at the summits. *P. crucifera* has not hitherto been detected on any other plant beside *Myrica Gale*, and I presume is peculiar to it. To my own mind, and I venture to think to the mind of most mycologists, such differences, coupled with the invariable phenomenon of the crystal surmounted hairs, will establish the validity of the species." William Phillips.

BERKELEY'S COMMENTS

Apparently in letter to Phillips: "I have with great pleasure examined your *Peziza*. I find that the crosses fall off, and I suspect that they are crystals; but if so the matter is not less curious. They are something like crystals of carbonate of lime, and nearly resemble some forms of crystals of oxalate of lime. The subject is worthy of further consideration. I have little doubt they are crystals."

"It is well known that oxalate of lime and binoxalate of potash occur not unfrequently in fungi, but we have never seen crystals of the former in such a curious position as in a minute white *Peziza*, lately sent by Mr. W. Phillips, one of the most indefatigable and accurate observers of minute fungi. Every hair with which the cup is clothed is terminated by a single crystal of a most beautiful and well-defined form, giving the whole under the microscope a most interesting appearance. The matter is at first puzzling, but the moment the crystals drop off their true nature is at once abundantly clear. M. J. B."

FIG. 1. *Dasyscypha crucifera*.

Phillips writes: "Though perfectly satisfied that this view was the correct one, I obtained the assistance of my friend, Mr. T. P. Blunt, a very able analytical chemist of this town (Shrewsbury), who satisfied himself by such chemical means as were possible with such minute objects that they consisted of oxalate of lime."

DIAGNOSIS

DASYSCYPHA CRUCIFERA (Phill.) Sacc. Syll. Fung. 8: 44. 1889.

Peziza crucifera Phill. Gard. Chron. II. 10: 397. 1878.

Lachnella crucifera Phill. Brit. Discom. 250. 1893.

Apothecia stipitate, reaching a diameter of .5-1 mm., shallow cup-shaped with hymenium pale yellowish, externally clothed with hairs intermixed with crystals of calcium oxalate giving them a granular appearance; stem reaching a length of .5-1 mm. and also clothed with hairs; hairs clavate septate, reaching a length of $80\ \mu$ and a diameter of $4\ \mu$; asci clavate, reaching a length of $40\ \mu$ and a diameter of $5-6\ \mu$, 8-spored; spores minute about $2 \times 5-6\ \mu$; paraphyses lanceolate.

On rotten wood.

TYPE LOCALITY: Europe.

DISTRIBUTION: Canada; also in Europe.

ILLUSTRATIONS: Gard. Chron. II. 10: fig. 11.

EXPLANATION OF FIGURE 1

Center, photograph of apothecia, about natural size; upper left, drawing of three apothecia much enlarged; left asci and paraphysis; right and bottom, hairs and crystals from outside of apothecia.

NEW YORK BOTANICAL GARDEN

INSECTS AS POSSIBLE DISTRIBUTORS OF PHYMATOTRICHUM ROOT ROT^{1, 2}

J. J. TAUBENHAUS AND L. DEAN CHRISTENSON

Studies were undertaken in 1933 to determine whether certain insects found in cotton fields are capable of spreading cotton root rot caused by the fungus *Phymatotrichum omnivorum*. These studies consisted of experiments to determine (1) if the alimentary fluids of soil insects have a lethal effect on the vegetative strands and the sclerotia of the fungus which would prevent dissemination by means of feces, and (2) the effect of the alimentary fluids of other insects, particularly leaf-feeding insects, on the viability of the spores of this fungus. Observations were also made to ascertain whether the destruction of fungus strands in the soil of cotton fields by the feeding of insects would allow recovery of areas infected with root rot.

EFFECTS OF SOIL INSECTS ON STRANDS AND SCLEROTIA OF PHYMATOTRICHUM OMNIVORUM

Three species of soil-inhabiting insects, white grubs (*Phyllophaga* sp.) and adults of *Blapstinus fuscus* Csy. and *Harpalus* sp., were caged and fed on freshly infected cotton roots covered with copious strand growth of *P. omnivorum*. When they had consumed sufficient quantities of this material, 16 of these insects were killed, surface-sterilized, and cultured on potato-dextrose agar in Petri dishes. The other insects were left undisturbed and their fecal pellets collected and cultured. A total of 2,169 fecal pellets were thus obtained, some of which were cultured without surface sterilization while others were surface-sterilized and cultured on potato-dextrose agar in Petri dishes. In not a single instance was *Phymatotrichum* growth obtained either from the fecal pellets or from the entire insects.

¹ Published with the approval of the Director as Contribution No. 290, Technical Series, Texas Agricultural Experiment Station.

² Bureau of Entomology, U. S. Dept. of Agriculture, Ms. No. 2694.

In making excavations in the field to find sclerotia of *P. omnivorum*, some are occasionally found in a damaged condition, as though fed upon by soil insects or other soil animals. However, none of the insects used in these experiments could be induced to feed on fresh, mature field sclerotia placed in screened cages in the laboratory.

EFFECT OF INSECTS ON SPORES OF PHYMATOTRICHUM OMNIVORUM

Cotton leaves from normal cotton plants were dusted with a heavy coating of spores of *Phymatotrichum omnivorum* and then fed to larvae of *Alabama argillacea* Hbn., *Heliothis obsoleta* Fab., and *Laphygma frugiperda* S. & A., and to adult grasshoppers in screened cages in the laboratory. A total of 4,759 fecal pellets were obtained from these insects; half of these were surface-sterilized and the other half were not sterilized, and both were cultured on potato-dextrose agar in Petri dishes. A number of grasshoppers and *A. argillacea* larvae were killed, surface-sterilized, and cultured on nutrient agar in Petri dishes. In not a single instance was *Phymatotrichum* growth obtained from either the fecal pellets or the entire insects.

In other experiments a heavy suspension of *Phymatotrichum* spores in a 1 per cent sugar solution in small dishes was placed in screened cages containing the following ants: *Pogonomyrmex barbatus* F. Smith var. *molefaciens* Buckley; *Dorymyrmex pyramicus* Roger var. *flavus* Perg.; and a species of *Prenolepis*. The ants partook of the sugar solution with apparent relish and imbibed large quantities of the spores of *P. omnivorum*. After 24 hours' feeding, they were killed, surface-sterilized, and cultured in potato-dextrose agar in Petri dishes. In not a single instance was *Phymatotrichum* growth obtained from the many cultures thus made.

FIELD OBSERVATIONS ON EFFECTS OF INSECTS FEEDING ON P. OMNIVORUM

Certain insects have been observed to feed upon the various stages of the fungus of root rot in nature, reducing the infective element in the soil which would reinfect plants during subsequent years. After considerable observation in the field it has been

concluded by the writers that this function is a minor one. It is doubted that soil animals would ever act in this capacity to the extent of clearing up root-rot areas. Such a conclusion is based on observations regarding the habits and abundance of organisms in the soil, as compared with the habits and abundance of the fungus in the same area. Where root-rot areas recover, soil organisms are perhaps a contributing factor but never a causative one.

SUMMARY

A number of insects were placed in screened cages in the laboratory, where they were fed on strands and on cotton roots freshly infected by *Phymatotrichum* root rot. The fecal pellets and some of the insects themselves were cultured on potato-dextrose agar in Petri dishes, but *Phymatotrichum* growth was not obtained from any of these cultures.

A number of insects were fed on cotton leaves which were dusted with a heavy coating of the spores of *P. omnivorum*, while others were fed on a sweetened solution containing a heavy suspension of *Phymatotrichum* spores. No growth of *P. omnivorum* was obtained from any of the cultures made of the fecal pellets or the entire insects thus fed. None of the insects used in these experiments could be induced to feed on the sclerotia of the fungus. From these preliminary tests it appears that insects are probably not involved in the spread of *Phymatotrichum* root rot.

FUNGI FROM LABORATORY REAGENTS

LEWIS B. LOCKWOOD¹

Occasional reference to the occurrence of molds in the reagents of a chemical laboratory may be found in chemical and mycological literature. In order to prevent the spoilage of some organic reagents, it is common practice to cover them with toluene, or to poison them with some substance which will not influence the chemical behavior of the material or interfere with the reactions of the reagent. Thom (5) reported the occurrence of *Penicillium lilacinum* Thom from nickel-electrotyping baths. Trabut (6) provisionally offered the name *P. cupricum* for an organism which differed from *P. glaucum* Link only in that it produced rose-colored conidia. Cultures were obtained from a solution (originally 9.5 per cent of CuSO_4) which had been used for seed treatment of wheat imported into France from Africa. DeSeynes (4) made a further study of the growth of *P. cupricum* Trabut on CuSO_4 solutions, and demonstrated that the rose color of the conidia was a reaction of the fungus to the CuSO_4 . *P. cupricum* Trabut was declared synonymous with *P. glaucum* Link. Gueguen (3) reported that *P. glaucum* grew on solutions of copper sulfate in the concentration of 1 part CuSO_4 to 200 parts water. Westling (8) described *Byssoschlamys nivea*, isolated from botanical specimens which were preserved in alcohol. *B. nivea* tolerated a concentration of 90 per cent of alcohol, or 5 to 10 per cent tannin. Gronchi (1, 2) described *Anematidium oxiphilum* Gronchi, which grew in the presence of N/2 hydrochloric acid and N/2 sulfuric acid. Wehmer (7) obtained a *Citromyces* sp. (*Penicillium*) from a solution which contained 0.5 per cent of sulfuric acid which had been used to hydrolyze cotton.

During the last three years, a number of rather striking examples of the tolerance of fungi to standard chemical laboratory reagents have come under observation in this laboratory. Fungi

¹ 252d Contribution from the Color and Farm Waste Division, Bureau of Chemistry and Soils, U. S. Department of Agriculture, Washington, D. C.

were found growing in reagents used for sugar determinations. These reagents consisted of a solution containing 2.48 per cent $\text{Na}_2\text{S}_2\text{O}_3$ and 0.2 per cent NaHCO_3 , and a modified Benedict's solution which contained 2.5 per cent $\text{CuSO}_4 \cdot 5\text{H}_2\text{O}$, 5 per cent Na_2CO_3 , and 9 per cent $\text{NaC}_6\text{H}_5\text{O}_7 \cdot 5\frac{1}{2}\text{H}_2\text{O}$. A fungus isolated from the modified Benedict's solution grew slowly, and formed a thin white pellicle of surface hyphae on cornmeal agar, but did not sporulate. Another fungus (no. 536) isolated from a similar solution proved to be a strain of *Aspergillus Sydowi* (Bainier and Sartory) Thom and Church, which was characterized by abundant sporulation upon a 2 per cent agar medium containing 15 per cent of glucose and 0.5 per cent of peptone, by the conidiophores arising from subsurface hyphae, and occasionally with branching of the conidiophores, each branch being terminated by a vesicle indistinguishable from those borne on unbranched stalks.

Fusarium orthoceras App. & Wr. (no. 537) was isolated from a 0.5 per cent solution of potassium acetate. This culture grew over the surface of the peptone glucose agar medium, and formed a deep-purple coloration, with abundant sporulation.

Penicillium lilacinum Thom was isolated from a 9 per cent solution of sodium acetate. *Endomyces* sp. was isolated from a 10 per cent CaCl_2 solution. This culture piled up a black yeast-like growth on peptone-glucose agar. True filaments with lateral buds somewhat similar to those of *Sporotrichum* were abundant in cultures, and single naked asci occurred rarely in old cultures.

Various *Aspergilli* of the glaucus and flavus-oryzae groups have been obtained from 20 per cent NH_4NO_3 and 10 per cent NaCl solutions. A vigorous strain of *A. fumigatus* Fres. with large heads was isolated from a 30 per cent KNO_3 solution. The conidia of this culture were at first pale ochraceous, passing through various shades of green to walnut-brown. A culture of the *A. niger* group with morphological characteristics lying between *A. niger* van Tieghem and *A. Phoenicis* (Corda) Thom, and a culture of *A. Tamaritii* Kita were isolated from a saturated aqueous solution of dimethyl-dihydro-resorcinol, and a sterile fungus was obtained from a saturated solution of resorcinol. A strain of *Penicillium purpurogenum* Stoll was isolated from a

0.5 per cent solution of H_3PO_4 . This culture produced glaucous acid from glucose, and in the presence of peptone, produced a very intense purple color, which became yellow in alkaline solution. Fungi have also been found in this laboratory in saturated solutions of indigo and 20 per cent solutions of gold chloride.

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NOTES ON BOLETES. IV

WALTER H. SNELL

The previous papers on the boletes have been concerned for the most part, with elucidating some of the obscurities or misunderstandings concerning the more common species. Henceforth, such discussions are bound more and more to concern the more rare and more obscure forms, and also the establishment of new species as they come to light.

SPECIES PREVIOUSLY DISCUSSED

Boletus Curtisii

In Notes III (pp. 356-358),¹ it was concluded that *B. carolinensis* Beardslee was the same as *B. Curtisii* Berk. because in the specimens of the latter examined there was no reticulation of the stipe as given in one of Berkeley's two descriptions.

In another examination of the Peck material at Albany during the past summer, I was again unable to distinguish any reticulation of stipes of plants labelled *B. Curtisii*. On the other hand, in Peck's type specimens of *B. fistulosus*, which are without doubt the same as *B. Curtisii*, as pointed out by Murrill, I did see a small amount of reticulation. This marking was found in small patches at the very apex of the stipe of one of the two plants. Thus the confusion in Berkeley's descriptions is explained. It appears then that the stipe of this species may be slightly reticulate in places, but from the material available to me, there can be no reason for calling the stipe "reticulate" and the conclusions of last year's notes still hold.

Boletus leucophaeus

This species was distinguished for the first time in this country in 1933 (see Notes III, loc. cit.). From collecting experience in 1934, this species appears to be not at all uncommon. I found it several times in several places in New York. It is quite likely

¹ Mycologia 26: 348-359. 1934.

that if old collections of specimens labelled "*B. scaber*" are examined carefully, it will be found that a small proportion of them are really *B. leucophaeus*. This species is easily identified by its dark brown to almost black, tomentose pileus and the spores larger and darker colored than those of *B. scaber*.

Boletus placidus

It is likewise true that some of the collections of *B. granulatus* will turn out upon examination to be *B. placidus*. When *B. granulatus* has been rained upon, especially during development of the sporophore, it will become much blanced if not quite white or sometimes becoming yellowish-white. *B. placidus* will likewise often have a greenish-yellow margin, although I have usually found it without yellow and with the white more ivory than pure white. The glandular dotting of the stipe of this species is coarser, with the dots usually confluent and connecting to form a coarse network. When once this feature has been noted, it will be remembered and will make tentative identifications simple. The European illustrations show this character very well. Further, there is a difference in the spores. Those of *B. placidus* are over $8\ \mu$ long, while those of *B. granulatus* are less than $8\ \mu$ long. In the American specimens I have found the spores of the latter have been only $6-7\ \mu$ long, but in some Canadian collections they have been $7-8\ \mu$.

SPECIES NOT PREVIOUSLY DISCUSSED

Boletus impolitus

As far as I am aware, this common European species has been reported only by Harkness and Moore from California and by McIlvaine from Pennsylvania, although the latter writer implied that it had been found and eaten by many individuals whom he knew. Atkinson reported *B. obsonium* Paulet as not uncommon in one of his collecting places in North Carolina, which species is considered quite generally by French mycologists to be the same as *B. impolitus*, or a vinaceous- or pinkish-tinged form of it. Peck did not see it and Murrill did not recognize it as an American species.

During the irritatingly dry summer of 1934 in the Adirondacks,

when collecting of fleshy forms was very unsatisfactory, I ran across this interesting species in one of my favorite collecting grounds near Riverside, N. Y. I found it first in a very young stage in which it was not identifiable but patently unusual. I ultimately made four more trips to the locality, driving 500 miles in all, meanwhile protecting it with a cage to keep the squirrels from destroying it and watering it to prevent it from mummifying because of the drought, but in the end I had two perfectly developed sporophores which were manifestly *B. impositus*.

These sporophores were found under a hemlock tree with hardwoods near by. In Europe it is described as associated with hardwoods by some writers and by others as only under oaks. In my locality, there were no oaks within a considerable distance. The only aberrant features manifested by my plants were as follows: changing of the flesh in places and of the tubes slightly to greenish when cut or bruised (no change in European plants); no odor of phenol or drugs as sometimes given for the European plants; one micron difference in the length of spores. Otherwise the agreement is as nearly perfect as it could be.

Boletinus paluster

This is apparently a rare species. At least I have searched for years for a red *Boletinus* in all the swampy regions I have passed in New England, New York and Pennsylvania without finding it. I have made special trips several times a summer to one tamarack swamp near Galway, N. Y., where Dr. E. A. Burt once found it, but to no avail. Then late in the summer, following a heavy rain, I found it in great abundance along a path that I have travelled no less than one hundred times in the past six years without coming across it. Further, judging by the descriptions available, it apparently has not been encountered before by many other collectors, for the descriptions are not only entirely inadequate, but also, if my series of collections of a couple hundred sporophores in all stages of development over a period of two weeks is any criterion, they are inaccurate in many details.

I had been looking for a "bright red" *Boletinus* (Peck's reproduction is almost a cerise). The color of my specimens was nothing if not a purple—a true purple that was very red or even

pinkish but certainly not any of the so-called reds. The young sporophores had a prominent veil which was at first fibrous-membranous and deep red, then arachnoid and pinkish, grayish or whitish. This veil was for a while appendiculate on the margin of the incurved pileus, but disappeared as the margin expanded. This veil also left at least a red line at the zone on the stipe where it broke away and sometimes was to be seen as deep-red punctations at this zone. There was, however, nothing that could be called an annulus.

The tube layer was decidedly decurrent, not slightly so, and it did not turn bluish-green no matter how much I bruised it. The shallow tubes, or almost merulioid pits, were definitely boletinoid, of course, but also in many specimens, the tube layer was so prominently veined as to be almost lamellate instead of poroid. It would seem as if in this species there is further evidence of the relationship of the boletes and the agarics, as has been suggested by many writers previously, through *Phylloporus* and *Paxillus*. Here in one collection was seen a complete gradation from the almost lamellate and intervenose to the poroid and veinless, although still with the pores in radiating rows instead of with free arrangement.

Further, the available descriptions speak of the stipe as yellow strongly tinged with red. The stipes of my specimens were yellow at the apex and base but in between were decidedly purplish red with no yellow, the red ending abruptly at the zone of attachment of the veil. The spores have been given as dirty-greenish-yellow when fresh, then pinkish-brown. I found them to be deep reddish purple, with no sign of green or yellow.

The odor and taste have not been recorded, so far as I know. Both are farinaceous, although after a little chewing the taste becomes slightly but persistently acid.

The foregoing characters will help to make more complete the technical description of this striking little *Boletinus*, but they are not necessary for a certain field identification. A small, red-purple, more or less turbinate or almost cantharelloid bolete found in northern swamps or moist places growing tamarack or balsam can be this species only. The common and somewhat similarly colored and marked *Boletinus pictus* is larger and more expanded, and is more likely to be met with near *Pinus Strobus*.

Boletus Gertrudiae

Shortly after examining *B. Curtsii* for reticulate stipes, I came across another error in this same respect in connection with *B. Gertrudiae* Peck. In the original descriptions, English and Latin, Peck made no mention of the topography of the surface of the stipe. In the type specimens at Albany, the stipes are today plainly reticulated for a distance of one to three centimeters at the apex. In Miss Wells' water color drawing, which accompanies the collection, no reticulation is represented, but the drawing is only a sketch without details, giving only general color, form and presumably size.

On the basis of this character, I would be inclined to place this species in the tribe Calopodes rather than in the Subpruinosi, where it would be placed if this reticulation were not present. The species of this latter tribe do not have reticulate stipes, altho *B. miniato-olivaceus* and *B. bicolor* may be reticulate with the descending walls of the tubes for a few millimeters.

Boletus indecisis

There has been much confusion concerning the taxonomic differentiation of *B. felleus*, *B. alutarius* and *B. indecisis*. *B. felleus* is the rosy-tubed and rosy-spored bolete, with bitter taste, common both here and in Europe. *B. alutarius* was distinguished by Fries on the basis of its mild taste and stipe more scrupose than reticulate. Peck found an American plant likewise with mild taste and with spores darker in color than those of *B. felleus* and with stipe reticulate like that of *B. felleus* rather than scrupose like that of *B. alutarius*. He named it well as *B. indecisis*, for its status has been more or less undecided ever since.

Several mycologists have thought that *B. indecisis* of this continent and *B. alutarius* of Europe are the same plant. Murrill² said that "specimens referred to *B. alutarius* Fries by American collectors probably belong in this category" (*B. indecisis*). In fact, the difference between a scrupose stipe and a reticulate one seems to be difficult of determination. Many French mycologists, however, believe that there is in reality no *B. alutarius*. For example, in a recent letter, Gilbert says the following:—" . . . *B.*

² The Boletaceae of North America. Mycologia 1: 4-18. 1909.

alutarius is in my opinion identical with *B. felleus* . . . The alveolae of the reticulations of *B. felleus* are often very deep. Fries says the taste is mild but one finds also the true *B. piperatus* mild. . . . It appears to me certain that there exists in France and also in Europe, only one bolete with rosaceous spores, *B. felleus*. Consequently, I consider *B. alutarius* an imaginary species."

If *B. alutarius* is the same as *B. felleus* in Europe, I am convinced that *B. indecisus* is a valid species. Not only does it have a mild taste and spores more brownish- or ochraceous-incarnate in mass than rosy-incarnate, as are those of *B. felleus*, but the sporophores are smaller, the flesh more firm, and the spores are distinguishable microscopically. The spores of *B. felleus* are elliptical to fusiform-elliptic but more inclined to be fusiform in shape, and measure $9-15 \times 3-4 \mu$, with most of them $12-14 \times 3.5 \mu$. The spores of *B. indecisus* are likewise elliptical to fusiform-elliptic, but inclined to be more elliptical than fusiform, and measure $10-15 \times 3.5-4 \mu$, with a few occasionally up to $20 \times 5 \mu$, but mostly $10-12 \times 3.5-4 \mu$ (that is, somewhat shorter and broader).

A large to very large sporophore with rosaceous tubes and spore print will in all probability be *B. felleus*. The taste may be mild, especially if there has been very rapid growth in rainy weather, although a prolonged test will usually disclose at least a trace of the bitterness. A smaller sporophore of this species will almost invariably be quite bitter to the taste after a very short test. If the taste of a small plant is mild, the flesh will be very firm by comparison with *B. felleus*, but if there is still question, the shorter and slightly broader, more elliptical rather than subfusiform spores, will in my experience give a safe determination.

Boletus crassipes, *B. badiceps* and *B. eccentricus*

Peck described four species from notes and drawings sent by McIlvaine. Whether or not Peck saw the dried specimens is not known, but at any rate there are no types extant. Accordingly, Murrill excluded three of these species from his treatment—*B. eccentricus*, *B. badiceps* and *B. fulvus*. He made *B. crassipes* questionably a synonym of *B. affinis*.

In as much as the lack of type specimens has been the only thing that has kept them from legal recognition, it has been my hope that I might find them and re-establish them as valid species. My efforts were rewarded this last summer by my coming across three of them. *B. crassipes* was found at Mt. Gretna, Pa., and *B. badiceps* at Ridgewood, Pa. by Miss Esther A. Dick and myself. *B. eccentricus* was collected in Greenville, R. I., by Mrs. Florence H. Hayward.

Of *B. crassipes*, Peck said that it is distinguished by the thick, beautifully reticulated stipe, the deep velvety brown color of the pileus and the yellow color of the flesh. It may be added also that the stipe is described as rather short and the pileus as projecting beyond the tubes. Hence, of course it bears no resemblance to *B. affinis*, but it does strongly suggest *B. auripes* Peck. The latter species has a brown pileus, yellow flesh, stipe yellow and reticulate, although usually not so extensively reticulated as that of *B. crassipes*. The stipe is usually longer than described for *B. crassipes*, but in some of my specimens of *B. crassipes*, the stipes were no thicker than the thinnest of *B. auripes*. Further, I have thus far been able to find no differences in the spores of the two species.

It may be that *B. crassipes* is a good species characterized by deeper brown pileus, flesh yellow not fading to white (as in *B. auripes*), and stipe more orange-yellow, more extensively reticulated, shorter and usually thicker. On the other hand, it may be found that *B. auripes* is more variable in color and proportions than now known and that these two species are the same, in which case the name *crassipes* would disappear as a synonym because of the priority of *auripes*. The two species must now be left distinct, however, until further study of more specimens of both can be made.

B. badiceps has a fine velvety appearance to the naked eye, but the surface is glabrous and not at all submentose. For this reason it more properly belongs in the tribe Subpruinosi, if one follows the Friesian system, rather than in the Subtomentosi, where it was placed by McIlvaine. The color of my specimens was bay red to somewhat chocolate brown; I did not see any dark maroon forms. The truncate or bevelled margin is usually

noticeable, although it often is not so pronounced as McIlvaine stated. The stipes were subbulbous and not ventricose and not markedly radicating. McIlvaine's figure 2 in plate CXVI³ shows no real radicating base. In color, the stipes of my sporophores were whitish pallid at the apex and below were tinged dingy yellow and in places streaked with reddish or brownish. They were slightly reticulate at the very apex, because of the decurrent walls of the tubes and within they were fibrous-hollow, perhaps from rapid growth after heavy rains.

The spores are ochraceous brown to ferruginous in mass, yellow to deep yellow under the microscope, subfusiform to elliptical and more or less irregular, and measure $10-20 \times 4.5-6.5 \mu$, mostly $12-14 \times 4.5 \mu$. The cystidia are either fusiform and hyaline or irregularly clavate and deep yellow, measuring $40-60 \times 7-8 \mu$.

B. eccentricus may be gray, yellowish-gray or brownish ochraceous sometimes sparingly tinged reddish. The tubes are yellow to brownish-yellow. The stipe may taper upward or downward, may be somewhat rugose or striate, and is white-reticulate. The spores are ochraceous in mass, pale brown under the microscope, in shape elliptical to fusiform or subfusiform and measure $10-17 \times 4-5 \mu$, mostly $12-14 \times 4.5 \mu$. The cystidia are bulbous-clavate to ventricose-rostrate or fusiform, hyaline, $40-50 \times 10-14 \mu$.

B. crassipes Peck is, therefore, now represented by specimen no. 270 in my herbarium at Brown University, *B. badiceps* by number 300 and *B. eccentricus* Peck by number 221. Watercolor drawings of all three are contained in my collection.

NEW SPECIES

Boletus turbinatus sp. nov.

Pileo crasso, turbinato, convexo, applanato vel depresso, sicco, tomentoso, ochraceo-brunneo vel paulo rubro-brunneo, 4 cm. lato; carne dilute citrina, infra cutem rubra, cyanescente, demum atro-rubra; tubulis adnatis vel decurrentibus, flavis, minutis, angulatis; stipite breve, deorsum attenuato, e levi paulo striato, dense furfuraceo, apice flavo, basi atro-rubescens, solido; sporis valde flavis sub lente, late fusiformibus paulo ellipsoideis, $13-21 \times 5-7 \mu$.

³One Thousand American Fungi. 1900.

Pileus rather thick so as to make entire plant more or less turbinate, convex to applanate or depressed, 4-7 cm. broad. Surface dry, minutely tomentose to buncy tomentose, ochraceous-brown to more or less reddish-brown (russet to Kaiser brown). Flesh light lemon yellow, reddish under the pellicle, changing to blue when cut and later becoming mahogany reddish. Tubes convex in mass, adnate to subdecurrent, at first light yellow, then dull yellow, 7-13 mm. or more long; mouths angular, 1-2 to a mm., slightly orange tinged. Stipe short, tapering downward, even to more or less striate, densely furfuraceous, yellow at apex to brownish Morocco red at base; within solid, light lemon yellow, changing to blue and later to mahogany; 1-2 cm. long, 7-10 mm. thick at apex, 4 mm. at base. Spores probably dark ochraceous-brown in mass, deep dull yellow under the microscope, broadly fusiform, few elongate or nearly ellipsoid, $13-21 \times 5-7 \mu$, mostly $14 \times 5-6 \mu$. Cystidia ventricose or fusiform-irregularly-rostrate, hyaline to yellow, $40-75 \times 7-8 \mu$.

Collected at Valley Park, Mo., by D. H. Linder. No. 345 in Herb. WHS, also in Herb. D. H. Linder.

In many ways similar to *B. chrysenteron*; differs in the more turbinate shape of the entire plant, lack of ochraceous or olivaceous tints to the pileus and not being red-cracked, in the tubes not changing to blue, the spores broader, more fusiform and deeper yellow, and the irregularly beaked, yellow cystidia.

***Boletus subdecorus* sp. nov.**

Pileo paullulum firmo, convexo vel plano-convexo, sicco, glabro, impolito, fusco-umbrino rubrotincto, 5-7 cm. lato; carne firma, alba, fracto dilute incarnescente; tubulis adnatis vel liberis, albis, parvis minutisve, subrotundis, tactis ferruginescentibus; stipite flexuoso, subinde excentrico, subbulboso et sursum attenuato, levi, apice paullulum reticulato, e glabro minute furfuraceo, concolore, apice albido, solido, fibroso; sporis ochraceo-brunneis, hyalinis sub lente, subfusiformibus vel ellipsoideis, $10-15 \times 3.5-5 \mu$, plerumque $14 \times 4 \mu$.

Pileus rather firm, convex to plano-convex, 5-7 cm. broad. Surface dry, dull to dull shiny, velvety appearing when fresh but glabrous, dark brown to chocolate-brown, sometimes tinged reddish. Flesh firm, pure white, sometimes becoming light flesh color when cut. Tubes adnate to free, white becoming more or less brownish flesh-color when wounded or in age, about 1 cm. long; mouths small to minute, subrotund, white, changing to rusty-brown where touched or in age. Stipe flexuous, perhaps somewhat eccentric, more or less bulbous and tapering upward,

even, perhaps slightly reticulate at the very apex, glabrous to minutely furfuraceous, reddish-brown to chocolate-brown, sometimes more or less streaked, perhaps paler to whitish at the apex and base; within, solid, fibrous, white; 7-9 cm. long, 15-30 mm. thick. Spores ochraceous-brown in mass, hyaline under the microscope, subfusiform or perhaps elliptical, $10-15 \times 3.5-5 \mu$, mostly $14 \times 4 \mu$. Cystidia truncate-clavate, fusiform or ventricose-rostrate, hyaline or yellow, $40-60 \times 7-9 \mu$. Odor and taste mild to mildly farinaceous.

Under oaks, Livingstonville, New York. July to September. No. 121 in Herb. WHS.

This species somewhat resembles *B. decorus* Frost, which to my knowledge has not been found by anyone since Frost except McIlvaine. *B. subdecorus* differs in the pileus being glabrous instead of subtomentose, and in the tubes being white and becoming rusty, instead of yellow changing to greenish. It apparently belongs in the *Edules*.

***Boletus pseudodecorus* Snell & Dick, sp. nov.**

Pileo paullulum firmo, e convexo plano-convexo, sicco, e pruinoso minute tomentuloso velutino, in maculis glabro, fuscumbrino rubrotincto, 5-8 cm. lato; carne molle, alba; tubilis adnatis, albis, fusciscentibus, parvis, rotundis; stipite subcurvato, subinde excentrico, supra reticulato, dense furfuraceo vel subtomentoso, rare pruinoso, saepe apice glabro, et basi tomentoso, concolore; sporis ochraceo-brunneis, hyalinis sub lente, ellipticis vel subfusiformibus, $8-14 \times 3-3.5 \mu$, plerumque $8-10 \times 3.5 \mu$.

Pileus rather firm, convex to plano-convex, 5-8 cm. broad. Surface dry, pruinose to very minutely subtomentose or minutely velvety, glabrous in spots, dark brown to chocolate-brown. Flesh soft, pure white, unchanging. Tubes adnate, white, becoming more or less brownish with age, up to 1 cm. long; mouths small, rotund, white, becoming brown like the pileus in age or on drying. Stipe more or less curved, perhaps eccentric, reticulate more than half the length, densely furfuraceous to minutely velvety or minutely subtomentose, rarely pruinose, perhaps glabrous at apex, often tomentose at base, dark brown to chocolate brown like pileus; within solid, white; 4-6 cm. long, 10-17 mm. thick. Spores ochraceous-brown in mass, hyaline under the microscope, elliptical to subfusiform, $8-14 \times 3-3.5 \mu$, mostly $8-10 \times 3.5 \mu$. Cystidia truncate-clavate to somewhat ventricose-rostrate, few hyaline, most deep yellow, $25-70 \times 6-12 \mu$. Odor and taste mild, perhaps somewhat farinaceous.

Under hardwoods, mostly oaks. Mt. Gretna, Pa. August and September. No. 272 in Herb. WHS.

This species closely resembles *B. subdecorus* in general appearance, but differs in the pruinose to subtomentose pileus, reticulate stipe and smaller spores. It differs from *B. decorus* Frost in its white tubes, reticulate stipe and smaller spores. It apparently belongs in the Edules with these other species.

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SEX-REACTION LINKAGE IN NEUROSPORA

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In his studies on the inheritance of response to heat-treatment in *Neurospora* Lindegren (5) found in a certain hybrid that the spores which germinated without heating were all non-conidial, and usually of sex-reaction type A. He has also proved (7) that the "pale" and "non-pale" factors in *N. crassa* are linked with the reaction factors. Recently Dodge (4) has pointed out that the factors for orange-colored conidia in *N. tetrasperma* may be linked with the reaction factors. At the suggestion of Dr. Dodge the writer has undertaken to repeat his experiments and also to analyze progeny from the mating S1 \times S9, the ancestral stock of the irradiated lines, to determine whether or not a linkage actually exists. The results of the writer's experiments show beyond doubt that the factors for the orange-color of the conidia in *N. tetrasperma* are linked with the sex-reaction factors as are also the factors for darkening of the substratum. In these experiments because of the limited time available for this work only the gross characters are dealt with, further work with a standard medium and a uniform set of environmental conditions should bring out other similar linkages.

MATERIALS AND METHODS

Single ascospores were germinated and isolated in the usual way from the progenies of the matings S1 \times S9, 9.7C4 \times S1 and 9.7C8 \times S9. Numbers 9.7C4 and 9.7C8 are races from the irradiated line G5.3 (3). After isolation these mycelia were first grown on corn meal agar to determine whether they were unisexual. The unisexual ones were then grown on dextrose agar to

¹ This work was done at The New York Botanical Garden during the tenure of a Research Fellowship from the China Foundation for the Promotion of Education Culture. The writer is greatly indebted to Dr. B. O. Dodge who suggested the problem and who provided some of the material and cultures and tendered critical advice. Thanks are also due to the authorities of The New York Botanical Garden for laboratory and library facilities.

bring out the linkage characters. Five days are usually required for the full expression of these characters, but they are often evident within three days. The races were then tested for their sex-reaction with tester strains. Finally the progeny from the matings $9.7C4 \times S1$ and $9.7C8 \times S9$ were analyzed. Unisexual component conidial strains from bisexual isolations from these matings and also from those of $S1 \times S9$ were separated out and studied.

PROGENY FROM THE MATINGS OF $S1 \times S9$

In the crosses of either $S1$ or $S9$ with any one of the opposite sex-reaction of the irradiated lines such as $9.7C4$ or $0.7C8$ as already pointed out by Dodge (4) the orange-color of the conidia is inhibited from expression in the offspring in which the lethal factor is present. In the progeny from the matings of $S1 \times S9$, the ancestral stock of the x-rayed lines, the expression of the linked factor is not interfered with. The fact that race $S1$ always produces more orange-colored spores than $S6$, a sister race of $S9$, was first observed by Dodge (1, 2), but it has not yet been proved that the factors responsible for this difference are linked consistently with the sex-reaction factors. The race $S9$ as we shall see is occasionally fluffy and produces quite an abundance of conidia, but the conidia are never bright orange-colored. The cause for the occasional fluffiness in $S9$ is unknown. The writer believes that the principal sex-reaction linkage involved in $S1$ is the factor for the orange-color of the conidia. Thus, when the races $S1$ and $S9$ were grown separately on dextrose agar² they show the following cultural characters:

- $S1$ (a)—Fluffy, with abundance of orange-colored conidia; substratum not blackened.
- $S9$ (A)—Mycelium usually applied closely to the substratum with few conidia; substratum blackened. Occasionally fluffy with quite an abundance of pale pinkish lilac- (never orange-) colored conidia.

Of a total of sixty-nine single-spore isolates from the matings of $S1 \times S9$, thirty-two gave the cultural characters of $S1$ on dextrose agar, thirty-five those of $S9$: The other two strains

² Difco's bacto dextrose agar was used throughout these experiments.

showed the cultural characters of both S1 and S9. When they were tested for sex-reactions the races in the first group all proved to be of the sex-reaction **a**, while those of the second group were of the reaction **A**. All the bisexual spores isolated, when grown on dextrose agar, produced the orange-colored conidia like race S1. Races 19.31 and 92 of the third group, however, showed characters as noted of both of the parental stocks, that is, they produced on dextrose agar an abundance of orange-colored conidia, and the substratum turned black. Because of these characters they were at first taken to belong to the group giving reaction **a**. But it was proved to be otherwise when they were tested out. These represent the only two cross-overs out of the sixty-nine isolates. In these two the orange-color of the conidia did not remain at a constant shade in numerous tests. It failed to show up in some of the transfers. This seems to indicate that environmental conditions had a great deal to do with the above inconsistency.

Fifteen unisexual conidia were isolated from the bisexual mycelium T17. Three of the fifteen isolates showed on dextrose agar the characteristics of S9, while the rest were like S1. Those showing the characters of S9 gave the reaction **A**, the others the reaction **a**.

The unisexual single-spore isolates from the matings S1 \times S9 are given below according to their sex-reactions:

Sex-reaction **a**: 1, 4, 6, 12, 18, 20, 21, 17.1, 19.24, 26, 37, 39, 40, 48, 50, 59, 60, 62, 64, 68, 71, 91, 93, 94, 95, 98, 61, 66, 4.43.3, 4.43.6, Tet. G, Tet. G₄.

Sex-reaction **A**: 16, 17.2, 19.31, 22.4, 22.10, 33, 34, 44, 46, 45, 56, 57, 75, 87, 88, 89, 90, 92, 73, 77, 65, 78, 144, 120, 23, 85, S3, S6, S13, 4.43.10, 4.43.8, 4.43.13, Tet. G₂, Tet. G₃, Tet. G₅, Tet. G₆.

Although the number of the isolates under test was not large, it was enough to show that the factor **O** for orange-color of the conidia is rather strongly linked to **a**, and the factor **M** for blackening of substratum is strongly linked to the factor **A**.

The blackening of the substratum is due to the diffusion of some black substance from the old mycelium.

PROGENY FROM THE MATINGS $9.7C4 \times S1$ AND $9.7C8 \times S9$

This set of experiments was only a repetition of what Dodge (4) had done. It differs from the work with the S1 and S9 races in that 9.7C4 and 9.7C8 are progeny from irradiated lines. Altogether one hundred and fifty-two unisexual single ascospore isolates were analyzed. According to their gross cultural characters they may be grouped into seven classes:

1. **AM(ol)**—Mycelium applied to substratum, conidia very few, occasionally fairly fluffy, brownish black masses of irregular size at the base of the slant, substratum becoming brownish black. $9.7C4 \times S1$: T39, T43, T54, T130, T127, T149, T183, 8, 14, 16, 48. $9.7C8 \times S9$: T13.2, T104, T128, T144, T147, 2, 6, 16, 17, 28, 35, 38, 50.
2. **AM(ol)**—Mycelium closely applied to the substratum as a white covering over the medium or more or less fluffy, conidia few or fairly abundant, pinkish lilac in color, substratum blackened. $9.7C4 \times S1$: T4, T14, T22, T45, T48, T55, T74, T92, T123, T128, T134, T132, T135, T129, T144, 1, 4, 25, 27, 30, 31, 44, 35. $9.7C8 \times S9$: T23.2, T63, T100, T108, T111, T125, T148, T168, 29, 30, 31, 40, 41, 49, 50, 55.
3. **am(OL)**—Fluffy (rarely not), abundance of bright orange-colored conidia, substratum clear orange-colored. $9.7C4 \times S1$: T5, T11, T28, T31, T42, T49, T52, T64, T78, T80, T81, T95, T126, T133, T137, T75, T142, T15.1, 10, 12, 23, 36, 38, 40, 42, 45, 46, 50, T57.1. $9.7C8 \times S9$: T13.1, T112, T114, T127, T133, T135, T137, T120, T105, T101, T134, T162, T174, T178, T150, 5, 12, 23, 43, 44.
4. **am(OL)**—Mycelium applied to substratum, conidia usually few, sometimes scanty pinkish conidia on the surface of the slant, brown or amber-colored masses of irregular size at the base of the slant, substratum becoming brown or amber-colored. $9.7C4 \times S1$: T10, T16, T44, T68, T102, 2, 3, 26, 34, 39, 43. $9.7C8 \times S9$: T8, T22, T28.1, T69, T73, T113, T131, T106, T109, T152, T159, T163, T183, 8, 11, 10, 18, 21, 26.
5. **am(OL)**—Fluffy orange-colored conidia, substratum dark brown. $9.7C8 \times S9$: T118 and T121.

6. **Am(oL)?**—Mycelium applied to the substratum, conidia few or fairly abundant, substratum not blackened. $9.7C4 \times S1$: T70, 41. $9.7C8 \times S9$: 48.
7. **Am(ol)?**—Mycelium applied to the substratum, conidia few, substratum not blackened. $9.7C8 \times S9$: 20, 36, 45, 47.

The genetic constitution of these seven classes as far as could be determined is given above. Symbols **A** and **a** are for sex-reactions, **O** for orange-color of conidia, **M** for blackening of substratum and **l**, for the lethal factor. All of the isolates except two producing fluffy mycelium and orange-colored conidia fall into the third class which gives the sex-reaction **a** and where the recessive lethal factor, **l**, is absent. In the fourth class of the same sex-reaction the factor **O** did not express itself on account of the presence of the lethal factor as was expected. But the races T118 and T121 of the fifth class from the matings of $9.7C8 \times S9$, although seemingly having the same genetic constitution as those in the fourth class, are fluffy and produce an abundance of orange-colored spores. The lethal factor in them does not seem to be effective in inhibiting the expression of the factor **O** for orange-color of the conidia.

In the strains 41, T70 ($9.7C4 \times S1$), 20, 36, 45, 47 and 48 ($9.7C8 \times S9$) which are of the reaction **A**, the melanistic factor, **M**, which is usually linked with this sex-reaction seemed to be absent. In the other progeny of the reaction **A** from the crosses of $9.7C4 \times S1$ and $9.7C8 \times S9$ it was found in a few cases such as in the races T45, 44, 4 ($9.7C4 \times S1$) 29 and 30 ($9.7C8 \times S9$) that the melanistic factor **M** is, in fact, a variable one. The reason that the strains, 41, T70 ($9.7C4 \times S1$) 20, 36 etc. ($9.7C8 \times S9$) all had a non-blackened substratum might be due to the fact that the environmental conditions to which they were subjected were not best for the expression of the black character as Lindegren has pointed out for the **M** factor. A case of crossing-over of the **M** factor in these races was, therefore, a doubtful one.

Since the unisexual single spore isolations from the crosses of $9.7C4 \times S1$ and $9.7C8 \times S9$ only amounted to one hundred and fifty-two, the ratio of the number of the matings producing perithecia with ascospores to the number of those producing perithecia with aborted asci, and the ratio of the number of

cultures not showing orange-colored conidia to the number of those showing them was not 3 : 1 in either case as must be expected with larger numbers.

OTHER SPECIES OF NEUROSPORA

The writer has also grown races of other species of *Neurospora* on dextrose agar to see whether they will also show different cultural characters for different sex-reactions. The species tested are the following: *N. sitophila*, *N. crassa*, *N. intermedia*, *N. Toroi* and a four-spored strain of *N. tetrasperma* collected in Texas by Mr. M. B. Morrow and sent to this laboratory by Dr. Charles Thom. The cultural characters they produced are given below.

1. *N. sitophila* 56.4 and 56.8—Fluffy, an abundance of salmon pink-colored conidia. No apparent difference in the cultural characters shown by the strains of different sex-reactions.

2. *N. crassa*—Fluffy, an abundance of salmon pink-colored conidia (pinker than *N. sitophila*) substratum not blackened. No apparent difference in the cultural characters shown by our tester strains of different sex-reactions.

3. *N. intermedia*—strain of reaction **a**—Fluffy, an abundance of saffron-colored conidia; sclerotium-like bodies abundant.

4. *N. Toroi*—**a**—Fluffy, conidia fairly abundant, yellowish, substratum not blackened. Strain **A**—Less fluffy than strain **a**, conidia fairly abundant, yellowish, substratum blackened.

5. Morrow strain—**a** (T21)—Fluffy, an abundance of orange-colored conidia, substratum somewhat blackened.

Morrow strain **A** (T23)—Fluffy, an abundance of orange-colored conidia, substratum somewhat blackened, more so than in T21 **a**; many large sclerotium-like bodies produced.

From the above it will be seen that in *N. Toroi* the factor for the blackening of substratum may be linked with the sex-reaction **A**, and in the Morrow strain the factor for producing sclerotium-like bodies in the strain of the sex-reaction **A** may also possibly be a sex-reaction linkage.

DISCUSSION AND SUMMARY

It is evident from what has been given above that the fungi under test seem to be very sensitive in their response to a slight variation in the environmental conditions. The inconsistency of

certain characters in the above experiments may be attributed to this cause. Regarding the variability of the melanistic factor in the few cases mentioned before, Lindegren (6) has also reported that in *N. crassa* the upper surface of the substratum became black on concentrated corn meal agar and that this did not occur on dilute corn meal agar.

In the progeny of the mating $S1 \times S9$ the gene **O** for orange-color and that for sex-reaction **a** remain together in over 97 per cent of the f_1 gametes. The gene for blackening of substratum and that for the sex-reaction **A** remain together in 100 per cent of the f_1 gametes. The factor **M** seems to be even more strongly linked to sex-reaction **A** than the factor **O** is to reaction factor **a**.

With regard to the offspring of the crosses of $9.7C4 \times S1$ and $9.7C8 \times S9$, the fact that all of the isolates producing orange-colored conidia are of the sex-reaction **a**, and that all of those with blackened substratum, with the exception of only two doubtful cases, are of the opposite reaction **A**, shows also unmistakably the existence of strong linkages. The exceptional activity of the factor **O** for orange-color of the conidia in the races T118 and T121 in spite of the presence of the lethal factor **l**, must have been due to the non-functioning of the lethal for some unknown reason. A sudden change in the lethal gene might have taken place. This change has not, however, inactivated its power to produce ascus abortion.

THE NEW YORK BOTANICAL GARDEN

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AN UNDESCRIBED SPECIES OF TAPHRINA ON CHINQUAPIN

ANNA E. JENKINS

(WITH 1 FIGURE)

The present taxonomic study of *Taphrina* on chinquapin (*Castanopsis chrysophylla* DC.) was initiated by the contribution of specimens from J. S. Boyce, which he gathered near Dorrington, Calaveras Co., California, on Aug. 16, 1934. The fungus was said to be abundant on young leaves in this region. Although not newly discovered it has not been collected for many years, and, as will be explained later, is evidently undescribed.

The *Taphrina* was first collected by Harkness¹ about 50 years ago. Identifying it as *Ascomyces Quercus*, he reported it along with this species on *Quercus* as follows:

"*Ascomyces Quercus*, Cooke.—On leaves of *Quercus Douglasii*, Folsom, and *Castanopsis chrysophylla*, Sierra Nevada, May–August. 3203, 3294."

Specimen 3294 is possibly not available at present. Through correspondence with J. T. Howell of the California Academy of Sciences, Lee Bonar of the University of California, F. J. Seaver of The New York Botanical Garden, and D. H. Linder of the Farlow Herbarium of Cryptogamic Botany, Harvard University, it has been learned that it is not at any of these institutions. Patterson² refers to a specimen sent her by Harkness, but a complete citation of the specimen is not given, and so far as known this is also not available.

There are at hand, however, two specimens of the fungus representing other early collections. These were gathered at Sisson, Siskiyou Co., Calif., in July and August, 1894, by Marshall A. Howe. The specimen collected in July is represented in

¹ Harkness, H. W. Fungi of the Pacific Coast, IV. Bull. Calif. Acad. Sci. 1: 1–13, 1885.

² Patterson, F. W. A study of North American parasitic Exoascaceae. Bull. Lab. Nat. Hist. State Univ. Iowa 3: 89–135, 1895.

the Herbarium of the University of California,³ as well as in The New York Botanical Garden, and the other in the Mycological Collections of the Bureau of Plant Industry, United States Department of Agriculture. All are labeled "*Taphrina castanicola* E. & E. n. sp." The specimen in the Mycological Collections, Bureau of Plant Industry is accompanied by the following note in Ellis' handwriting:

"*Taphrina castanicola* E. & E. is the same as the *Taphrina quercus* of Harkness' Catalogue,⁴ but it seems to me to be different from that species and we have called it *T. castanicola*. If the host is really *Castanopsis*, *T. Castanopsidis* would be better, but Prof. Howe of the University of California who sent this specimen said 'on *Castanea chrysophylla*,' hence the name *T. castanicola*. Perhaps you had better write Prof. Howe and see what he says of the host name." To whom these remarks were addressed is not known. The leaves of both specimens are definitely of *Castanopsis chrysophylla*, which was originally described as *Castanea chrysophylla* Douglas.

Howe's specimens most certainly were collected too late to have been considered in Patterson's treatise on the Exoascaceae; under *Taphrina coerulescens* (Mont. & Desm.) Tul. she discusses there the *Taphrina* on *Castanopsis* sent her by Harkness as follows:

"Upon the affected areas which may constitute one-half of the leaf surface the asci are closely crowded together; they are in size near the minimum measurements of *T. coerulescens* and have only one process extending very slightly between the epidermal cells, but there seems to be no difference of sufficient importance to constitute even a variety of the species under consideration."

On the basis of material studied by the writer the fungus is clearly distinct from *Taphrina coerulescens*. The asci are cylindrical rather than club-shaped as in that species, as well as longer and narrower. The fungus is evidently a distinct species as stated by Ellis in the note quoted above. Since no diagnosis was given by Ellis and Everhart for the fungus it is here described as new under the specific name proposed by them:

³ Information sent by Lee Bonar, in a letter dated Apr. 15, 1935.

⁴ The article by Harkness already cited is evidently referred to here.

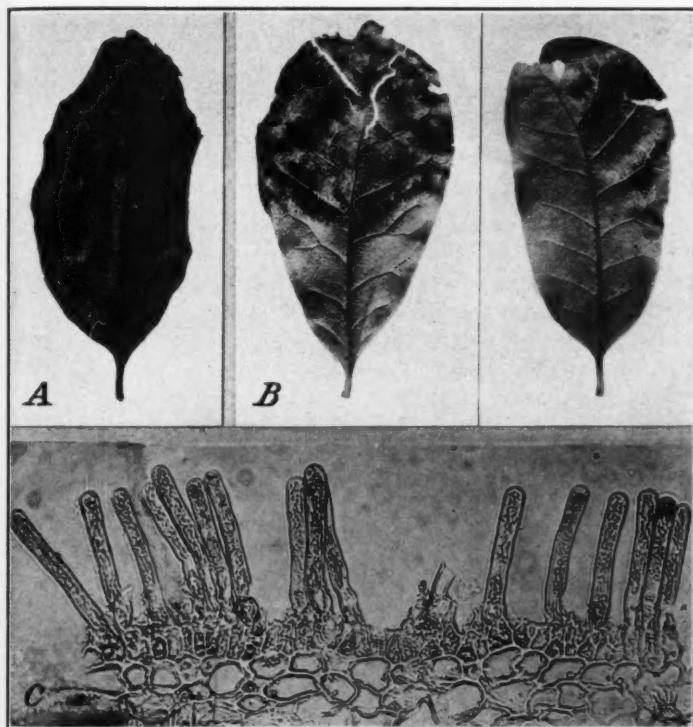


FIG. 1. *Taphrina* on *Castanopsis chrysophylla*: A and B, lower surfaces of leaves from (A) Sisson, Calif., July, 1894, M. A. Howe, and (B) from the vicinity of Dorrington, Calif., Aug. 16, 1934, J. S. Boyce ($\times 1$); C, hymenium on lower surface of leaves from specimen shown in A ($\times 200$); photographs by M. L. F. Foubert.

***Taphrina Castanopsidis* sp. nov. Ellis & Ev. (in herb.)**

Hymenium hypophyllous; asci standing close together, cylindrical, rounded at apex, entire structure reaching 80 to 165 μ in length, upper exposed part 13–17 μ in diam., basal part extending slightly between the epidermal cells, not modified, or variously formed, more or less pointed, truncate, bent out of line with the rest of the structure, or enlarged reaching 26 μ in diam., sometimes uneven or with 2 or 3 lobes up to 10 μ in length and occasionally a slender, somewhat curved process reaching 40 μ in length; ascospores 8 in number, up to 10 μ in diam.; sprout conidia 3–5 $\mu \times 1.5$ –2.5 μ ; asci filled with sprout conidia or those that have borne sprout conidia often purplish.

Hymenio hypophyllo; ascis dense confertis, cylindraccis, apice rotundatis, totis (basi includente) 80–165 μ longis; parte superiore exposito 13–17 μ diam.; parte basali intra cellulas epidermicales paulo extendente, immutata vel varie formata, plus minusve acuta, truncata, inflexa vel inflata, usque 26 μ diam., interdum irregulari vel 2–3-lobata, usque 10 μ longa, interdum processu curvato 40 μ longo praedita; ascosporis octonis, usque 10 μ diam.; conidiis secundariis 3–5 $\mu \times$ 1.5–2.5 μ ; ascis conidia continentibus vel vacuis saepe purpureis.

Distribution: On young leaves of *Castanopsis chrysophylla*, affecting part or the entire leaf surface, diseased areas on lower surface of leaf brown and yellowish green on upper surface, often concave below and convex above. California.

Collections examined: Sisson, Siskiyou Co., Calif., M. A. Howe, July 1894 (ex Univ. Calif. Fungi of Calif. 121, in Herbarium of The New York Botanical Garden); August 1894 (in Mycological Collections, Bureau of Plant Industry). Dorrington, Calaveras Co., Calif., Aug. 16, 1935, J. S. Boyce (ex Herb. J. S. Boyce 2287).

Type: In Mycological Collections, Bureau of Plant Industry.

DIVISION OF MYCOLOGY AND DISEASE SURVEY,
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WASHINGTON, D. C.

CULTURAL STUDIES OF THREE NEW PYRENOMYCETES¹

L. E. WEHMEYER

(WITH 3 FIGURES)

Among the specimens of the stromatic Pyrenomycetes kindly sent to the writer by various workers, there have been a number which have been difficult to determine or apparently undescribed. There is already so much confusion in many of the genera of this group, however, that the writer feels great reluctance in the description of new species. In many cases a monographic study of a genus is necessary to even determine what are specific limitations. The three cases here treated are so clear cut, however, that there seems to be little doubt of their individuality.

ENDOTHIA VIRIDISTROMA

In April of 1934, a *Valsa*-like fungus was collected by Dr. J. H. Miller on *Cercis canadensis* on the campus of the University of Georgia at Athens and sent to the writer for determination. The strongly developed, colored stroma and the polystichous arrangement of the perithecia (FIG. 1) excluded the plant from the genus *Valsa*, and the hyaline spores and non-sulcate ostioles eliminated the possibilities of its being an *Eutypella*. The remaining possibility was the genus *Endothia*, with which its characters were in close agreement. Both Fries (1, p. 385) and Shear (2, p. 14), in their generic descriptions of *Endothia*, give the stromata as being some shade of yellow, orange or red, and so far as the writer has been able to discover no species of *Endothia* with greenish stromata has been described. The difference in color does not seem sufficient to the writer for generic separation. This material was sent to Dr. C. L. Shear for his opinion and he too agreed that it was con-generic with *Endothia* and should not be excluded on the basis of color, but expressed the desirability of a knowledge of the conidial stage as further evidence.

¹ Papers from the Department of Botany and the Herbarium of the University of Michigan, No. 549.

The writer had intended to culture the fungus, if possible, and on October 10, 1934, ascospores were sprayed onto nutrient agar. Within twenty four hours, these spores had become greatly swollen, globose and measured $9-11 \times 7.5-8.3 \mu$. One or two thick germ tubes, some 5μ in diameter were pushed out from each spore (FIG. 3: 5). These germ tubes grew in a tortuous manner and soon branched several times. Transfers from single spore colonies onto oatmeal agar produced a coarse matted, cottony growth on the surface which was white to grayish-white or yellowish at first but became yellowish-green to a deep dull green with age.

After several weeks growth, a few spherical, superficial stromatic pycnidia were formed, which increased in size up to about 1 mm. in diameter. These stromata were clothed externally with a grayish tomentum. Internally they consisted of an interwoven compacted mass of rather thick walled greenish-yellow prosenchyma, the hyphae of which were $1.5-2 \mu$ in diameter. Each stroma contained a number of angular, flask shaped to irregular cavities, all of which emptied into a common ostiole or mouth through which the numberless conidia were exuded as a single, yellowish, thread-like spore horn. These cavities (FIG. 3: 3) were $200-300 \times 200-400 \mu$ and possessed a definitely differentiated wall of dark yellow- or olive-brown pseudoparenchyma which separated easily from the surrounding stromatic tissue. The inner cells of this wall were lighter in color, were filled with a denser protoplasm and gave rise to numerous, simple or fasciculately branched conidiophores which were somewhat swollen at the base and measured $8-11.5 \times 1-2 \mu$. From the apex of these conidiophores, minute cylindric to allantoid, hyaline, one celled conidia, measuring $2.5-3(3.5) \times 0.8-1 \mu$ were abstricted in large numbers (FIG. 3: 1). When sprayed onto nutrient agar, these conidia germinated abundantly within twenty four hours. They also swell enormously before germination (FIG. 3: 2), reaching a size of $6.5-7.5 \times 8-8.5 \mu$ and showing a somewhat thickened wall. The single germ tube formed is $3.5-5 \mu$ in diameter.

On November 14, steam sterilized twigs of *Fagus grandifolia* and *Carpinus caroliniana* were inoculated from single spore

cultures. Similar hemispheric, grayish-green, superficial, pycnidial stromata, exuding single yellowish spore horns, were formed on these twigs, but no perithecial stromata were ever seen.

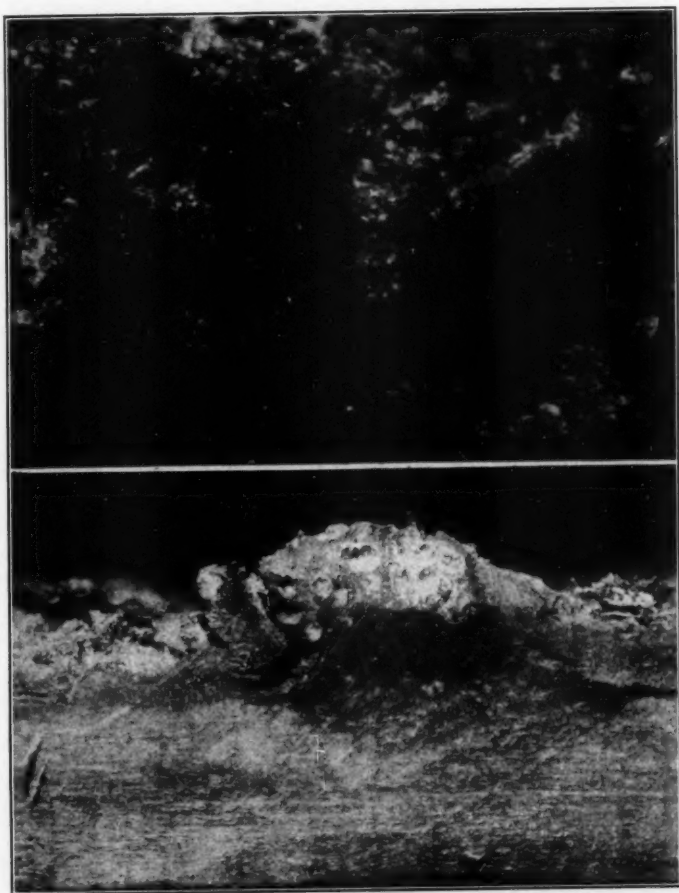


FIG. 1. *Endothia viridistroma*: upper figure, surface view of stromata and ostioles ($\times 8$); lower figure, radial section through perithecial stroma ($\times 20$).

These ectostromata on twigs originate within or just beneath the periderm but at maturity, when they reach a diameter of 1 mm., they may include the bark cortex as deep as the first layer of

stone cells. In section, the pycnidial cavities are more numerous and more regular in outline than on agar and the walls may lie loose within the more or less disintegrated stroma.

These condial stromata agree very well, in general, with the type of pycnidial formation found in other species of *Endothia*. The pycnidial stromata in this species differ chiefly in having larger and more distinct pycnidial locules than in the species of *Endothia* with orange colored stromata. This plant is therefore described as a new species:

***Endothia viridistroma* sp. nov. (FIG. 1 AND 3: 1-6)**

The stromata (FIG. 1, upper fig.) appear on the surface as widely erumpent, rather superficial, blackened, often confluent masses, 2-5 mm. in diameter and 1-1.5 mm. thick. The surface of the stroma is thickly beset with black, elongate, spine-like, often tortuous ostioles, up to 1 mm. in length, which are easily broken off. In section (FIG 1, lower fig.), the stroma is seen to be dark green to yellow green within and largely erumpent superficial. The stroma penetrates slightly into the bark cortex and remainders of cortex cells can be seen in the superficial portion, which is probably entöstromatic in origin. The perithecia are polystichous in their arrangement in the upper portion of the stroma. They are often radially elongated, small, $200-350 \times 150-250 \mu$ and with long narrow necks which emerge as the bristly ostioles. The asci (FIG. 3: 6) are numerous, small, clavate, non-stipitate, $15-20 \times 3-4 \mu$. The spores (FIG. 3: 4) are biserial, minute, hyaline, one-celled, very slightly allantoid or slightly swollen and then almost ellipsoid, and $5-6 \times 1-1.5 \mu$.

Pycnidial stromata (on twig cultures) tuberculate, spherical, erumpent-superficial and ectostromatic. Stroma light to dark yellow-green and prosenchymatous. Pycnidial locules numerous, irregular to ellipsoid in outline, surrounded by a definite greenish-black pseudoparenchymatous wall which often separates from the surrounding stroma. Locules opening to the exterior through a common ostiole which often forms a papillate swelling on the surface. Conidia numerous, cylindric to allantoid, one-celled, hyaline, $2.5-3.5 \times 0.8-1 \mu$, born on simple or branched, cylindric to tapered conidiophores, $8-11 \times 1-2 \mu$.

On *Cercis canadensis*, Campus, Athens Ga. April 30, 1934. Collected by J. H. Miller. Type in author's herbarium (No. 3634).

Stromata in superficie comparentia sicut cumuli late erumpentes, nigrescentes saepe confluentes, 2-5 mm. diametro, 1-1.5 mm. crassitudine. Stromatis

superficies ostiolis nigris, productis, ascicularibus, fragilibus, saepe tortuosis usque ad 1 mm. longitudine obsessa. Stroma sectum atroviride vel flavoviride intus et ample erumpenti-superficiale. Perithecia parva, $200-350 \times 150-200 \mu$, polysticha parte stromatis superiori, saepe radialiter producta et cervicibus longis angustis emergentibus sicut ostiola horrida. Asci numerosi, parvi, clavati, non stipitati, $15-20 \times 3-4 \mu$. Sporae biseriatae minutae, hyalinae, unicellulae, levissime allantoideae vel turgidulae paene ellipsoideaeque.

Stromata pycnidialia tuberculata, rotunda, erumpente-superficialia et ecto-stromatica. Stroma pallide vel atro flavo-viride et prosenchymatum. Loculi pycnidiales numerosi, extrema corporum irregulares vel ellipsoidei, pariete haud dubio viridi-nigro parenchymato saepe stromate circumdato disiungenti. Loculi per ostiolum commune saepe tumorem papillosum superficiale formantem dehiscentes. Conidia numerosa, cylindrica vel allantoidea, unicellula, hyalina, $2.5-3.5 \times 0.8-1 \mu$, conidiophoris simplicibus vel ramosis, cylindricis vel acuminatis, $8-11 \times 1-2 \mu$ sustentata.

EUTYPELLA VIRESCENS

A second fungus with olive-green stromata was sent to the writer by J. W. Hotson in 1930, who collected it in Oregon on *Sambucus callicarpa*. Cultures of this fungus were made in 1930 but these were lost before conidial stromata were obtained. On October 10, 1934, sprays of ascospores were again made on a nutrient agar, but no germination took place. The original material was then placed in a damp chamber for several days and ascospores thus matured germinated on October 23 after twenty-four hours on agar. The germinating spores swell enormously and measure $16.5-21 \times 3.5-5 \mu$. One, or more usually two, germ tubes, $3-5 \mu$ in diameter are pushed out from their ends and produce numerous short lateral branches. It is interesting to note that these spores were brought to germination after more than four years under herbarium conditions.

On oatmeal agar, single spore isolations produced a pure white, even, smooth, cottony weft on the surface. Only after some time, and in a few cultures, were small orange colored conidial pustules formed and very few conidia were found on agar.

On November 7, steam sterilized twigs of *Sambucus canadensis* were inoculated from single spore cultures. Here also conidial formation was very slow and infrequent, due in part, apparently, to the very thin bark of this species. On April 16, 1935, inoculations were again made, this time onto sterile twigs of *Ulmus*, *Salix*, *Acer* and *Ribes*. On all these hosts pustules appeared

within two to three weeks. On *Ulmus*, the erumpent stromata produced were white, rather large (1-2 mm. in diameter) and widely scattered. On *Acer*, they were very minute, thickly scattered locally and greenish-yellow, whereas on *Salix* they were

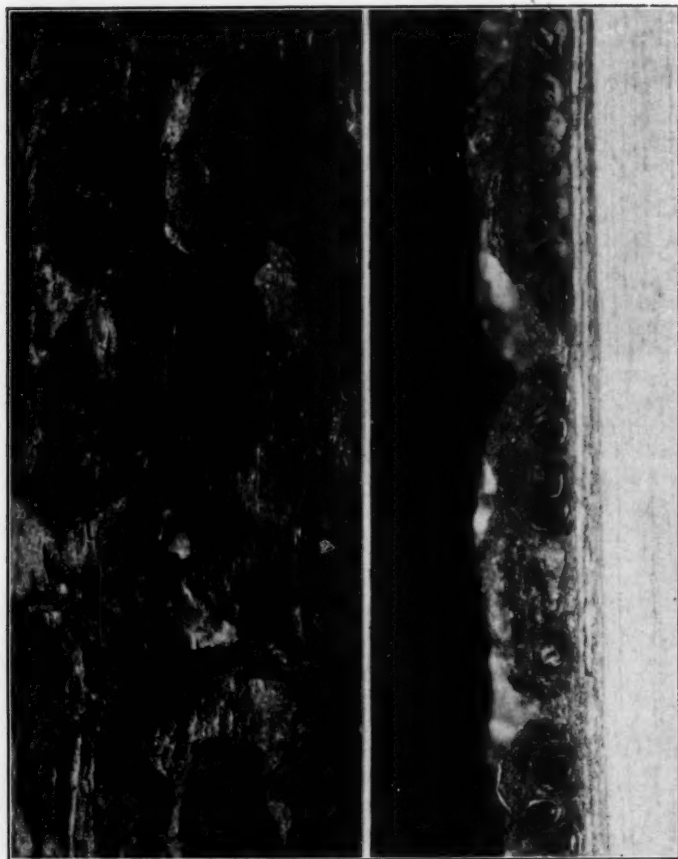


FIG. 2. *Eutypella virescens*: left hand figure, surface view of stromata ($\times 15$); right hand figure, radial section of perithecial stromata ($\times 15$).

intermediate in size, similar in color and thickly scattered over the entire twig. Such variations on different types of bark are of

interest in such a genus with so many host forms and variants of doubtful identity.

On *Salix*, (FIG. 3: 16) there is a more or less effuse formation of hyaline stromatic tissue upon and within the surface layers of the bark cortex. This stromatic layer is increased at certain points to form irregularly spherical masses of stroma within which conidial locules arise, or to give rise to conic stromatic discs which rupture the periderm. The conidial stromata are partially ecto- and partially entostromatic in nature as is characteristic of the genus *Eutypella*. Within these stromata (FIG. 3: 16) there are formed one or several very irregular to labarynthiform chambers which are lined with a conidial hymenium bearing the long filiform, hyaline, variously curved, one-celled conidia which are $22-40 \times 1 \mu$. Neither the cavities nor the stromata have any differentiated wall. Numerous perithecial initials with typical "Woronin hyphae" were seen just beneath or within the base of other sterile stromatic enlargements.

Inasmuch as there appears to be no other similar *Eutypella* with a greenish perithecial stroma so far described, this species is here given as new.

***Eutypella virescens* sp. nov.** (FIG. 2 AND 3: 13-16)

Stromata pulvinate, widely erumpent and strongly pustulate, $1-2 \times 0.5-1$ mm., often confluent for greater distances. Surface of stroma blackened, rupturing the periderm in a stellate manner by the pressure of growth and containing the scattered, stout, conic, often sulcate ostioles (FIG. 2, left). Interior of stroma bright olive- to yellow-green. Perithecia large, $600-750 \times 500-600 \mu$, somewhat radially elongated, crowded in the greenish entostroma, and with short stout necks. Marginal blackened zones faint and irregular when present. Asci (FIG. 3: 13) born in a definite peripheral hymenium, clavate, 8-spored, long stipitate, $85-100 \mu$ long with stipe, sp. p. $30-50 \times 5-8 \mu$. Spores (FIG. 3: 14) yellow-brown in mass, biseriate in the ascus, allan-toid, one-celled, yellowish-hyaline, $6.5-9.5 \times 1-2 \mu$.

Pycnidial stromata (on twig cultures) irregularly ellipsoidal, immersed in the surface layers of the bark cortex. Locules one to several, irregular to labarynthiform, without differentiated walls, lined with a conidial hymenium. Conidia long filiform, hyaline, one-celled, variously curved, $22-40 \times 1 \mu$.

On *Sambucus callicarpa*, Oregon, June 1930, from J. W. Hotson (No. 6). Type in author's herbarium (No. 340).

Stromata pulvinata, late erumpentia et valde pustulata, dense sparsa, $1-2 \times 0.5-1$ mm., saepe confluentia. Stromatis superficies nigrescens, peridermium adhaerentia stellariter incrementi pressu rumpens et ostiis valdis, turbinatis saepe sulcatis obsita. Stroma lucidum olivaceum vel flavido-viride intus. Perithecia magna, $600-750 \times 500-600 \mu$, rotunda vel elongata aliquando radialiter cervicibus brevibus robustis in entostroma conferta. Zonae marginales nigrescentes obscurae et irregulares si adsunt. Asci in hymenio circumstanti certo clavati, 8-spori, longe stipitati, $85-100 \mu$ longi (cum stipite), p. sp. $30-50 \times 5-8 \mu$. Cumuli sporarum flavo-brunnei; spores ascum intra biseriatae, allantoidae, unicellulae, flavo-hyalinae, $6.5-9.5 \times 1-2 \mu$.

Stromata pycnidialia irregulariter ellipsoidea in stratis corticis superficialibus summersa. Loculi complures (vel interdum unus) irregulares vel labyrinthiformes, sine parietibus distinctis, hymenio conidiali obsiti. Conidia longe filiformia, hyalina, unicellula, diversiter flexa, $22-40 \times 1 \mu$.

DIAPORTHE STRUMELLA (Fries) Fuckel var. LONGISPORA

The material upon which this discussion is based was sent to the writer by H. S. Jackson who collected it on *Ribes* at Toronto, Ontario. This material agreed in all respects to *Diaporthe strumella* (Fries) Fuckel except for the fact that the asci and spores were much larger. *Diaporthe strumella* and its conidial stage have previously been reported by the writer (3, p. 178) and will not be discussed here.

This occurrence of apparent varieties of species of *Diaporthe* differing in the elongate ascospores has been noted previously in two distinct cases, once in *D. oncostoma* (Duby) Fuckel (4, p. 142) where elongate ascospores occurred in material matured in a damp chamber and also in a specimen in von Höhnelt's herbarium, and again in a collection of *D. Fagi* Wehm. (4, p. 146), in which case the material was described as a new variety *longispora*.

The spores of the genus *Diaporthe*, and also of many other fungi, are more likely to vary in length than in diameter, and it was probable that these over-sized spores might be the result of more favorable or luxuriant growth. On the other hand, it is equally true that many related species of *Diaporthe* are very similar in many respects except as to spore size. It was of particular interest therefore to culture this long-spored variety and determine whether spore size were constant or merely a variable dependant upon environment.

The spores of typical *D. strumella* (FIG. 3: 12) are $11-16 \times 2-3.5 \mu$ and the asci are $37-45 \times 6-9 \mu$, whereas those found in Jackson's collection (FIG. 3: 8) were $18-23 \times 3-3.5 \mu$ and $70-75 \times 7-8 \mu$ respectively. These ascospores when sprayed onto nutrient agar on October 21, 1934, germinated within twenty-four hours by means of, usually, two stout contorted germ tubes some 5μ in diameter (FIG. 3: 9). Single spore cultures on oatmeal agar produced a whitish flocculent growth which turned grayish to black with age, due to the formation of blackened dorsal zone on the surface. Numerous pycnidial stromata were formed on the agar surface.

On January 7, 1935, sterilized twigs of *Ribes* were inoculated from single spore cultures. Irregular blackened areas were formed locally on these twigs and in three to four weeks numerous small pustules, which proved to be ectostromatic pycnidia were formed abundantly over the entire infected area. These conic to hemispheric ectostromata originated on the bark surface beneath the periderm and attained a diameter of $300-800 \mu$ when fully mature. The basal portion penetrated somewhat into the bark cortex, and here there was initiated a flattened locule which became spherical with age and usually developed a definite neck-like opening to the surface, pushing out the numerous conidia in a pale, dull yellowish spore mass or spore horn. These locules possessed a definite wall of olive colored pseudoparenchyma lined within by the hymenium of hyaline filiform conidiophores. In young pycnidia both the alpha and beta type of conidium were present but in older locules only alpha conidia were found. The alpha conidia (FIG. 3: 11) were fusoid to fusoid-cylindric, occasionally tapered toward one end $9-12 \times 2-3 \mu$. The beta conidia were long filiform, straight or somewhat curved and $15-22 \times 1-1.5 \mu$. Blackened ventral zones were formed deep in the wood or along the margin of the pith, but were present laterally only at the margin of the fruiting areas.

Mixtures of the alpha and beta conidia were sprayed onto nutrient agar and practically all of the alpha conidia had germinated within twenty four hours by means of a single tortuous germ tube, $3-3.5 \mu$ in diameter, whereas not a single definite case of germination of a beta conidium was seen.

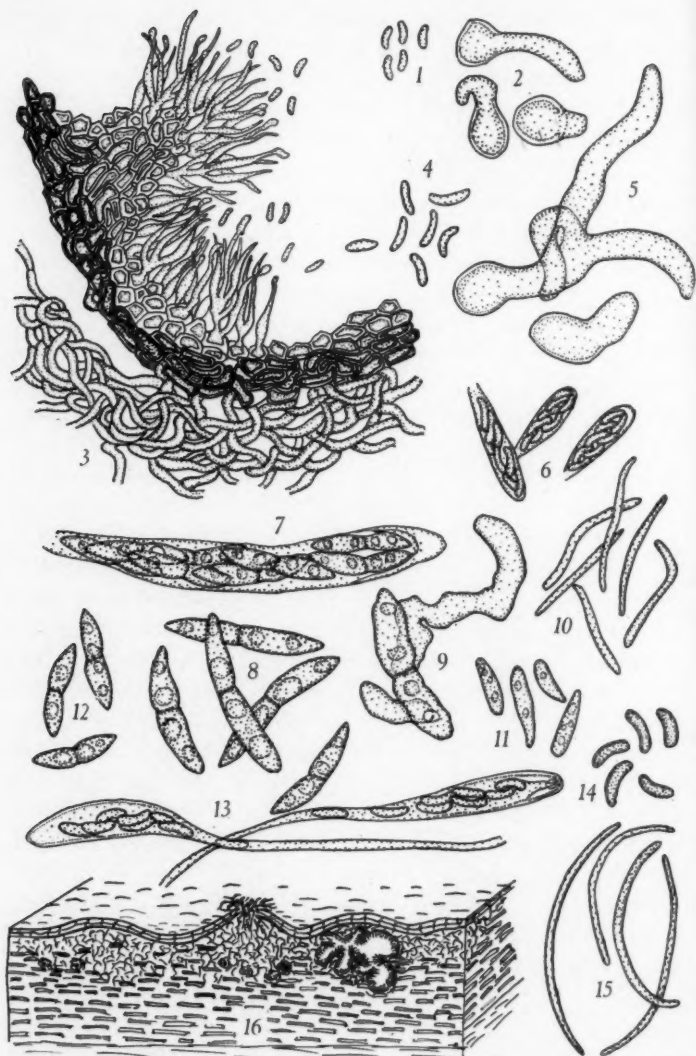


FIG. 3. (Asci and spores $\times 1000$) 1-6, *Endothia viridistroma*: 1, conidia; 2, germinating conidia; 3, radial section through wall and hymenium of prosenchymatous and parenchymatous layers; 4, ascospores; 5, germinating ascospores, showing enormous swelling upon germination; 6, asci; 7-11,

After these cultures had apparently dried out, the twigs were remoistened with sterile water, on March 25. On April 8, perithecia were found beneath some of the sterile ectostromata. Later, by May 1, elongated ostioles, up to 0.5 mm. in length, had pushed through the sterile discs. The perithecia were 300–400 μ in diameter and clustered in small groups beneath the sterile, conic, yellowish- to greenish-gray ectostroma. The asci (FIG. 3: 7) were 60–80 \times 6.5–8 μ , and the biseriate spores (FIG. 3: 8) were long fusoid-ellipsoid, tapered at the ends, straight or more usually curved, constricted at the septum and 17–27 \times 3–4 μ . Spores from the later developed perithecial stromata measured 15–23 \times 3–4 μ and the asci measured 75 \times 7–9 μ .

In general structure, both in nature and in culture, therefore, this fungus is practically identical with *Diaporthe strumella*. The size of the ascospores and asci, however, have been distinctly and permanently larger, at least throughout this generation from ascospore to ascospore. It should also be noted that there is a correlated increase in size of both the alpha (6–8 \times 2.5 μ in *D. strumella*) and beta (11–15 \times 1.5 μ in *D. strumella*) conidia over those previously obtained from typical *D. strumella* ascospores. This would indicate that, in this case at least, the greater spore and ascus size is a genetic and not an environmental variation. The cause of such variation is, of course, still obscure. Nevertheless, the fact that such variants do arise within the population of a fungus species and may become fixed indicates one way, at least, in which species differentiation could have taken place in this genus. If the plant under consideration were not so obviously a variant of *D. strumella*, it would most certainly be considered a distinct species. Under the circumstance of this obvious relationship it is here described as a variety of *D. strumella*.

Diaporthe strumella (Fries) Fuckel. var. *longispora*: 7, ascus; 8, ascospores; 9, germinating ascospore; 10, beta conidia; 11, alpha conidia; 12, ascospores of *Diaporthe strumella* (Fries) Fuckel. (compare with those of var. *longispora* in fig. 8); 13–16, *Eutypella virescens*: 13, asci; 14 ascospores; 15, type of conidium found in pycnidial locules; 16, radial section through bark cortex of *Salix* twig representing stromatic development as found in culture on this host; pycnidial locule to right; young perithecial stroma in center.

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DIAPORTHE STRUMELLA (Fries) Fuckel var. *longispora* var. nov. (1)
(FIG. 3: 7-11)

Stromatic and perithecial characters as in *Diaporthe strumella* (Fries) Fuckel. Asci clavate, sessile, with a refractive ring in the apex, $60-80 \times 7-9 \mu$. Spores biseriate, two-celled, hyaline, fusoid-ellipsoid, usually slightly curved, constricted at the septum, four-guttulate, ends tapered, $15-27 \times 3-4 \mu$.

Pycnidial strumata as in *D. strumella*. Alpha conidia one-celled, hyaline, fusoid to fusoid-cylindric, sometimes tapered toward one end, $9-12 \times 2-3 \mu$. Beta conidia one-celled, hyaline, long filiform, straight or variously curved, $15-22 \times 1-1.5 \mu$.

On *Ribes* sp. April 29, 1934, Toronto, Ontario, collected by H. S. Jackson (No. 6083). Type in author's herbarium (No. 3635).

Stromatibus et peritheciis *D. strumellae* similis. Asci clavati, sessiles apice circulo lucem refringenti, $60-80 \times 7-9 \mu$. Sporae biseriatae, fusoido-ellipsoideae, bicellulae, hyalinae, rectae vel paulo curvae, saepio contractae, 4-guttulae, apicibus acuminatis.

Pycnidiiis D. strumellae similis. A—conidia unicellula, hyalina, fusioidea vel fusioidea-cylindrica, aliquando ad apicem unam versus acuminata, $9-12 \times 2-3 \mu$. B—conidia unicellula, hyalina, longifiliformia, recta vel diversiter curva, $15-22 \times 1-1.5 \mu$.

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STUDIES OF TWO SPECIES OF ENDOGONE IN CULTURE¹

BESSIE B. KANOUSE

(WITH 33 FIGURES)

During the summer of 1934, numerous collections of *Endogone sphagnophila* Atk. were obtained on sphagnum in Mud Lake Bog, Whitmore Lake, Michigan, by Dr. Alexander H. Smith. The abundance of fresh material thus made available was an incentive to renew work on the genus *Endogone* in an endeavor to secure the life history of a zygospor-forming species from culture. Cultures were obtained, and the results from them not only furnished information on that species, but also justified conclusions drawn from a cultural investigation made several years ago on another species of the genus. The results of the earlier study were reported before the Mycological Section of the Botanical Society of America, but were not published. They are included in this paper under the discussion of *Endogone occidentalis* sp. nov.² (FIG. 22-32).

The genus *Endogone* is well known from its characteristic zygosporocarpic stage. Due to a lack of sufficient information regarding the sporangial stage, much speculation has arisen relative to its taxonomic position. Bucholtz (3), Atkinson (1), and Thaxter (7) have given in detail the history of the genus and of the various proposed affinities, so that a complete account need not be repeated. Only the considerations upon which the cultural work has a direct bearing will be discussed.

The cultural data presented in this paper extends and clarifies

¹ Papers from the Department of Botany and the Herbarium of the University of Michigan No. 538.

² Sporocarpia subglobosa, 2-4 mm., flocculenta, demum squamosa, intus lutea; zygosporae globosae vel ovoideae, 35-47 × 50-60 μ; chlamydosporae globosae, 40-60(100) μ.

In putrido legno. Legit C. H. Kauffman, Lake Quinault, Washington, Oct. 23, 1925. Specimen typicum in Herbario Universitatis Michiganensis conservatum.

our understanding of the genus *Endogone*; furnishes additional proof for the inclusion of the genus in the Mucorales; and gives weight to the assumption that the Mucoraceae and Endogonaceae are closely related families. Furthermore, the results of the investigation make it expedient to remove two species, *E. malleola* Hark., and *E. reniformis* Berk., from the genus *Endogone* and to place them in a new genus, for which the name *Modicela* is proposed.

Examination of the sporocarps from the sphagnum in Mud Lake Bog showed that they corresponded in all respects to the description of *E. sphagnophila* published by Atkinson (1). His interpretation of the common sphagnum-inhabiting species of *Endogone* has been selected in preference to that of authors who have included this fungus in *E. pisiformis* Link. It is believed that too much emphasis has been placed upon the brief description and simple illustrations published by Link (6) in 1809, and copied by Fries (4) in 1823. Link's illustrations are reproduced in figure 33: 4 accompanying this paper. It is easily understood how such a divergence of interpretation, as is expressed by Buchlotz (3) and by Thaxter (7) could have arisen from the meager information supplied by Link. It is altogether possible that if cultural data were available on fungi that pass under the name of *E. pisiformis*, as it is considered in the broad sense, that distinct differences would be found bearing out the supposition that *E. sphagnophila* is a distinct species. In any event, it seems more logical to refer the cultures upon which this report is based, definitely to *E. sphagnophila* Atk., which concept accurately describes the fungus from which the cultures were derived, rather than to refer them to the inclusive *E. pisiformis*.

CULTURAL STUDIES

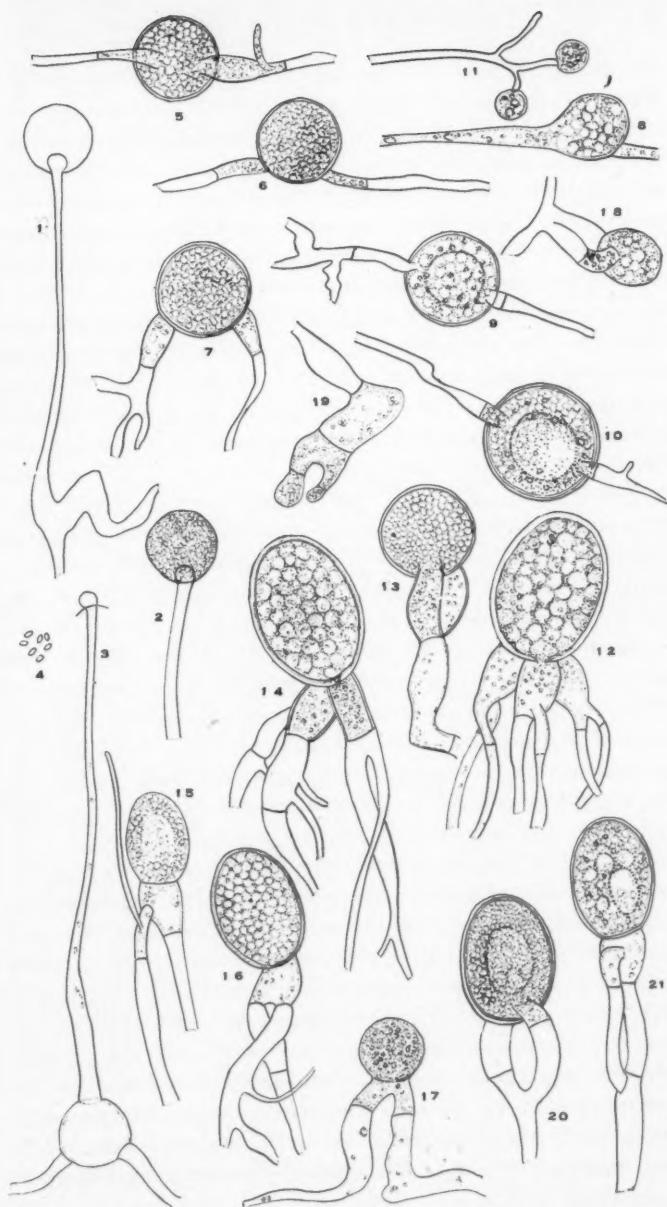
(a) ENDOGONE SPHAGNOPHILA Atk. (FIG.1-21).

Sporocarps were sterilized in a .1 per cent solution of HgCl_2 and rinsed thoroughly in sterile distilled water as soon as they were brought into the laboratory. Portions of the sporocarps were placed on $2\frac{1}{2}$ per cent malt agar plates which were placed in a refrigerator registering 12 degrees C. Mycelium developed from two such transfers. The hyphae grew well on synthetic

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FIGS. 1-21.

maltose agar, on 1, 2, and $2\frac{1}{2}$ per cent malt agars. The vegetative hyphae formed a compact, flat, growth, grayish-white in color. Under the microscope the mycelium appeared yellowish in color due to the numerous, conspicuous oil droplets contained in the protoplasm. The hyphae measured $3-18\mu$ in diameter. Septa were sparingly formed in places other than in connection with the reproductive organs. Sporangia were borne terminally on sporangiophores which arose thickly on the mycelium. The sporangiophores are erect, slender, and unbranched. They reach a height of $250-500\mu$. The sporangia are spherical and measure $18-28\mu$ in diameter. (FIG. 1, 2.) The spherical columellae are of a distinctly mucoraceous type and measure $5-8\mu$ (FIG. 3). The sporangial wall is fragile and dehisces leaving a small collar at the base (FIG. 3). The sporangiophores are ellipsoid, hyaline, and measure $2 \times 3.5-4\mu$ (FIG. 4). With the appearance of sporangia, the cultures assume a soft rosy color, which on the rich malt agar media, is "russett-vinaceous"³ (R.) to "light russett-vinaceous." Under the microscope the color of the individual sporangia is bright "English red" (R.). Lendner (5) ascribed the color in the sporangia of *Mucor Romannianus* Moeller as "probablement due a la substance interstisielle." No definite colored substance was found in the sporangia of *E. sphagnophila* nor could the color be attributed to the spores, although it may have been there or in the sporangial wall. The wall is so quickly diffuent in a water mount that not much can be seen except minute fragments.

Chlamydospores are produced abundantly, accompanying the production of sporangia. They form first in and upon the inoculum where they make a compact layer. Later they are found everywhere except at the margin of the cultures. Often they are as densely packed as are the zygosporos in a sporocarp, and look remarkably like them when examined under the low power of the microscope. They are usually spherical, rarely ellipsoid or irregular, and measure $30-50-80\mu$; and they are intercalary (FIG. 5-10). The hyphal attachments are commonly separated by the diameter of the spore, however, some spores were found which seemed to have been formed by a piling up of

³ Ridgway, R. Color Standards and Color Nomenclature.

the protoplasm against a septum, rather than from an equal flow of protoplasm from two directions. In the latter cases, the hyphal attachments are, then, near to each other on the surface of the spore and as the spore increases in size, gives the appearance shown in figures 5 to 7. The protoplasmic contents of the chlamydospores is at first coarsely granular. Later uniform fatty globules are evenly distributed throughout giving the effect of endospores. Finally a large oil droplet is formed (FIG. 10). The oily contents gives the young chlamydospores a brownish-yellow color, but in old spores the color is intensified so that frequently it is not unlike that seen in zygosporangia developed in sporocarps. Mature chlamydospores possess two very thin walls about 3μ in thickness. When broken and treated with chloral-hydrate the wall swells but little. The outer wall is a continuation of the hyphal wall. The inner wall is tardily formed and the two are nearly indistinguishable. The reagent colors the endospore wall "Brazil red" (R.) and the exospore wall blue. The endospore wall makes the separation between the hypha and spore. Septa are found in the hypha, frequently very near the enlarging spore. When the spores regenerate they either send out numerous hyphae or produce a sporangiophore and sporangium as is shown in figure 3.

In addition to the large conspicuous chlamydospores, there are sometimes smaller ones also which measure $8-10\mu$ in diameter. They are spherical and are either terminal or intercalary (FIG. 11).

Zygosporangia were obtained in culture. They were produced on mycelium grown on 1 per cent malt agar. The luxuriant vegetative growth made on the high per cents of malt agar indicated that malt was a particularly favorable medium. Hence it seemed desirable to observe further the reactions of the fungus when lesser amounts were employed. Consequently a series of cultures was made in which malt was reduced to 1, 0.75 and 0.5 per cents, together with checks grown on 2 per cent malt agar media. Zygosporangia appeared in cultures derived from single sporangiospore isolations, from single chlamydospores and from gross cultures. They appeared only in cultures grown on the 1 per cent malt. While they did not appear regularly in

every culture on this medium, they were present in every one of a series of cultures that was set up and left on the laboratory table from June to November. The zygospores produced in culture were like those formed in sporocarps in both shape and size (FIG. 12-15). They were formed in the manner described for the species by Atkinson (1), whose studies were made on zygospores formed in sporocarps from a bog. The gametangia were conspicuous. However, many of the zygospores formed in culture were atypical in that they possessed several pairs of gametangia. As many as five pairs were sometimes seen connected with one zygospore. Whether or not more than one pair actually functioned in the formation of the zygote could not be ascertained. The size of such zygospores did not differ from that of the typical zygospores, hence there was no reason to suppose that they were the result of multiple fusion. The complicated connections of the zygospores and the several pairs of gametangia were difficult to trace. Some of the typical zygospores and some of the abnormal ones are shown in figures 12-16. The walls of the zygospores did not become as thick nor was the color of the contents as bright in culture as in those formed in sporocarps. When broken and treated with chloriodide of zinc a continuous endospore was seen and the walls then swelled to approximately the thickness of the zygospore walls formed in sporocarps. However, when the oil drop was forced from the zygospore the deep yellow color was easily apparent. What the inhibiting factors were that prevented the zygospores from developing uniformly like those in the sporocarps was not determined. There were indications suggesting that the presence of too much moisture might be a disturbing factor, hence a few trials were made to overcome that situation. The fungus was grown on folded paper pads, the ends of which were immersed in a malt solution, and others were grown on malt agar in a desiccator. Neither set of experiments produced sporocarps.

The production of the zygospores could be correlated more closely with the factor of nutrition. Of the media tried, the 1 per cent malt seemed to provide conditions for the best development of the fungus in all of its phases. As might be expected, the growth of the mycelium and the number of sporangia de-

creased in direct proportion to the amount of malt used. The optimum 1 per cent malt media seemed to allow a good vegetative development and to reduce the nutritional supply to a degree favorable for sexual reproduction. The results illustrate another application of the Klebsian principle which affirms a control of the development of an organism through the nutritional supply. It is impossible to reconstruct in a laboratory the conditions prevailing in a bog. If they could be duplicated with a nicer precision than has been achieved in the attempts just set forth, it is certain that these results could be improved.

It is interesting to note that in habit of growth, and in production of color in the sporangia, *E. sphagnophila* resembles *Mucor Romannianus*. In fact when grown together on 2 per cent malt agar the two species are indistinguishable macroscopically although their hyphae do not mingle. The morphological characters of the sporangia are similar in the two species, but the peculiar chlamydospores and the zygospores of the sort present in the *Endogone* species are not known for the *Mucor*. The chlamydospores of *M. Romannianus* are small, are formed in chains, and are definitely a mucoraceous type. *Mucor Romannianus* var. *angulospora* Maoum. likewise differs from *Endogone sphagnophila*. The spores and color are less like *E. sphagnophila* than are those of *M. Romannianus*.

Another significant feature worthy of mention, since it has such an important bearing on the culture technique, is the freedom from contaminations that one experiences in working with material collected in a sphagnum bog. The usual soil and wood-inhabiting fungi do not seem to be present, so that it is possible to have under observation on agar, for several days, fragments of the mycelium and zygospores, without the usual overgrowth of unwanted fungi.

Attempts to get additional cultures from the sporocarps as they were brought into the laboratory failed. Sporocarps in the initial stages of development were persistently sought but were never found. With but few exceptions mature zygospores only were present. Figures 16-19 show some of the earliest stages observed. That it is not easy to secure the fungus in culture is testified by the fact that innumerable trials have been made

during this and previous seasons by the author without success, and failure has been reported by other investigators also. To what the success of the present report depends is merely a conjecture. Some of the younger sporocarps contained mycelium that was apparently still in an active growing stage, to judge from the dense protoplasmic contents, while in the sporocarps having mature zygospores the mycelium was practically devoid of protoplasm. It is possible that there is a relatively short period in which the active mycelium will respond to the conditions of culture. Probably the presence of such hyphae in a few of the transfers was the source of the cultures not only of *E. sphagnophila* but also of *E. occidentalis* discussed elsewhere in this paper.

Throughout the various studies on the genus, attempts have been made to germinate zygospores. Thaxter, Atkinson and Bucholtz were not able to do so. The author tried the expedient of alternately wetting and drying, of freezing and thawing with no appreciable effects. Some zygospores were left in a tray of a refrigerator for six months; others were kept for three days at a temperature approximating a minus 20 degrees F.; while still others were heated to 60 degrees C., and others were kept moderately warm for periods of many days. Portions of sporocarps were fed to two species of snails and to the common greenhouse slug. The excrement containing zygospores was plated on malt agar. Other zygospores were put directly on the agar media previously mentioned, and also on an agar medium made from sterilized sphagnum. Some were treated with weak acids, others were put in distilled water or in water in which sphagnum was soaked. Most of the spores appeared unchanged by the treatments. Only those that were subjected to the extreme cold disintegrated and appeared dead. The conditions under which they can be made to germinate remains still a mystery, and is one of the intriguing problems in the phycomycetes.

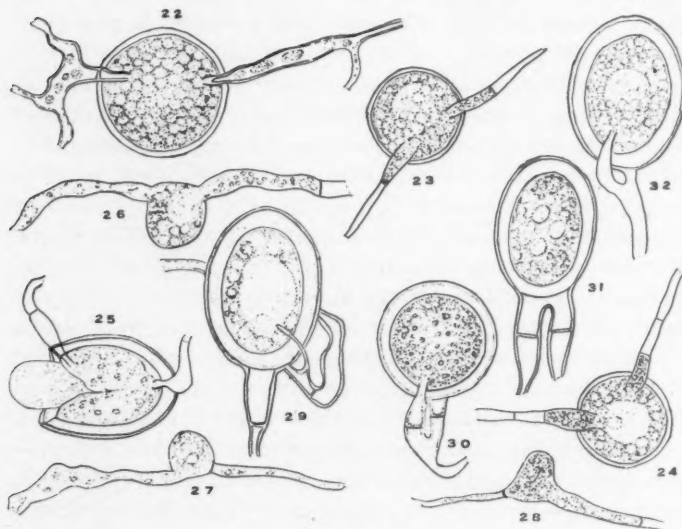
This species, which was studied several years ago, was collected in the autumn of 1925 by Doctor C. H. Kauffman, at Lake Quinault, Washington. The material was received on decayed wood packed in moist sphagnum. No adequate description could be found for the fungus and the name *E. occi-*

dentalis is proposed for it. It was cultured as soon as it reached the laboratory at the University of Michigan. The same methods of technique were employed with this fungus that were described for the treatment of *E. sphagnophila*. Successful cultures were derived from a few of the many fragments of mycelium transferred to maltose synthetic agar. When chlamydospores were formed, additional cultures were made from single isolations of them also.

Cornmeal, oatmeal, and 2½ per cent malt and maltose synthetic agars were favorable substrata. The mycelium grew rapidly on the agars and formed a flat, compact, surface growth. Aerial mycelium was infrequent and was found only at the edges of petri dishes and may have been caused by the different atmospheric conditions. The hyphae were thin walled when young. In old cultures many became empty and were very like the vesicular hyphae found in the mature sporocarps. The hyphae were sparingly septate and varied in diameter from 3–18 μ . Conspicuous oil droplets gave the mycelium a faintly yellowish color. Some of the enlarged segments of the mycelium were filled with protoplasm and remained viable for long periods of time since subcultures were readily obtained from them.

Chlamydospores formed as soon as the mycelium had made a growth measuring a few millimeters. They became densely packed together in the region of the inoculum and also made a compact layer over the surface of the agar. Some were also scattered within it. In a few instances the chlamydospores piled up in such masses that they gave somewhat the appearance of sporocarps, however, no peridial layer and no dense gleba were differentiated, only a loose web of hyphae developed on which the spores were borne. The chlamydospores were either terminal or intercalary, usually the latter (FIG. 22–27). They were spherical, only occasionally ellipsoid or pyriform. The spherical ones measured 24–60–125 μ in diameter. They were formed in the same manner as were those described for *E. sphagnophila*. At maturity they possessed two walls, an outer exospore wall which is a continuation of the hyphal wall, and a continuous endospore wall. Together they measure 4–6 μ in thickness. When stained with chloriodide of zinc the outer wall turned

yellowish in color like the hypha and the inner wall stained "Brazil red" (R.). Young spores stained "Ajuga red" (R.) and within half an hour faded to "dark grayish lavender" (R.) or "Ranier blue" (R.). The action of the stain and the structure of the wall could be observed to the best advantage when the



FIGS. 22-32.

spores were crushed. When this was done, the lamellate structure could be discerned easily. The broken walls always swelled remarkably increasing in thickness to as much as $12\ \mu$. (FIG. 25) The endospore swelled more than did the outer wall. The contents of young chlamydospores appeared as homogeneous, coarsely granular protoplasm heavily charged with oil which soon became aggregated into spore-like globules. The oil finally separated out and formed into a large drop or into one large one and several smaller ones. The old spores were colored so deeply orange by the oil that in mass on a slide they were not unlike zygospores in appearance. In fact they were so interpreted at first, but the absence of gametangia precludes their being so considered. The presence of two definite walls gives the im-

pression of azygospores. Especially was this effect given by the ellipsoid, terminal spores. However, after a detailed study of hundreds of them the conclusion was reached that probably all were true chlamydospores. The figures published by Thaxter (7) for several species of *Endogone* are very like the chlamydospores that were found in the cultures of the two species studied.

No zygospores were seen in culture. A few hyphae were found which appeared like the very early steps in conjugation but no later stages of development were observed that would confirm that opinion. Figures 26-32 were drawn from sporocarpic material. Sporangia were not found in any of the cultures. The fungus was kept in bacteria-free condition for a period of five years, and during that length of time there was no appreciable change in the cultural characteristics or in the morphological aspects of the fungus. Unfortunately the cultures were lost before interest was renewed through the investigation of *E. sphagnophila*. It is obvious that *E. occidentalis* is less adaptable to culture than was *E. sphagnophila* as it was impossible to obtain the complete cycle of development. The publication of the data on *E. occidentalis* was delayed in the hope of finding sporangia or of germinating the zygospores, by either of which achievements the connection between the cultures and the sporocarps could be strengthened. Neither objective was accomplished. When cultures of *E. sphagnophila* were obtained, the striking similarity of the development of chlamydospores in the two species was at once apparent. Because the results of the investigation on *E. sphagnophila* were so much more complete, yet coincided so perfectly with certain aspects in the development of *E. occidentalis*, a satisfactory interpretation of the earlier study is made possible.

DISCUSSION

The most recent taxonomic treatment of the genus *Endogone* is that given by Thaxter (7). He made it clear that the arrangement proposed, was a usable one, though more or less arbitrary, and that as our information concerning the species increased, our notion of the genus would probably be reconstructed. Species included by him in the genus fall into three categories based

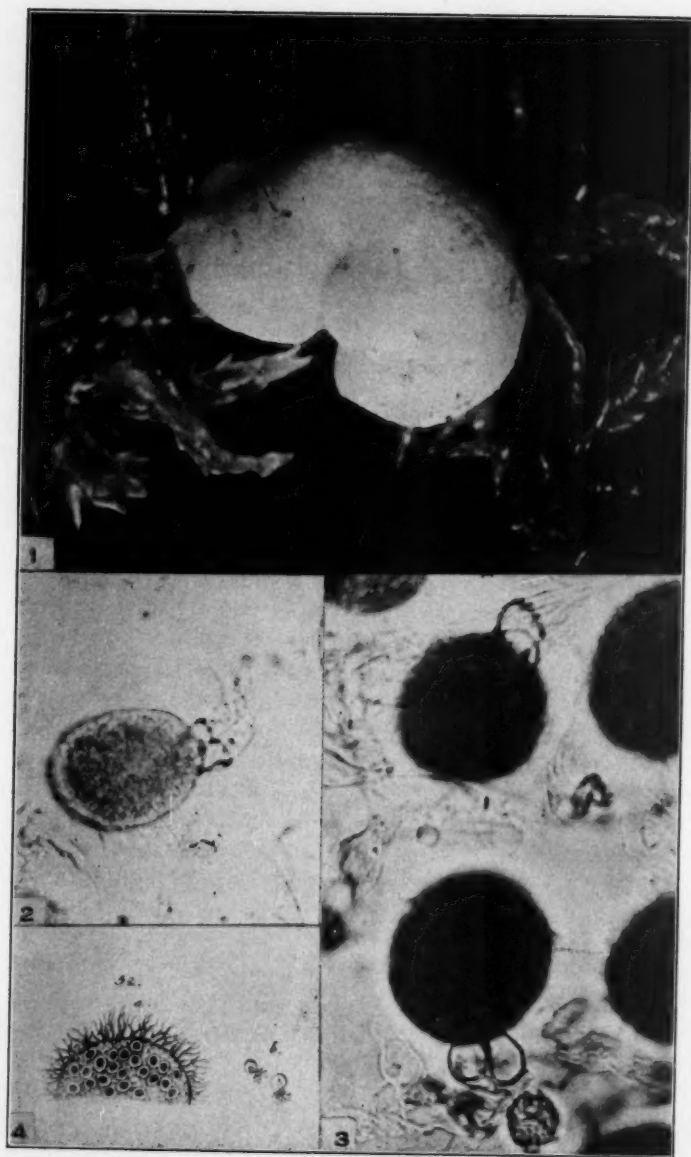


FIG. 33.

upon the type of spore produced. The largest and the best known group is composed of species in which only zygospores are known. A second group comprises species in which chlamydospores alone are found. As Thaxter pointed out, the inclusion of this group in the same genus with the zygospore-forming species "was based entirely on a general resemblance in habit and habitat and similarity in the appearance of the two types of spores." He added substantial evidence for the assumed connection from observations on *E. fasciculata* Thaxter in which species he found zygospores and chlamydospores intimately associated in the same spore mass. Definite proof of the fact that these two spore forms are to be found in the same species is given by the results of the cultural experiments reported in this paper for *E. sphagnophila* and *E. occidentalis*. From these results it is certain that these two groups can no longer be considered separate.

Another category consists of two species, *E. malleola* Hark. and *E. reniformis* Berk. in which only sporangiospores are produced. Again Thaxter stated that in putting them in the genus *Endogone*, he found no evidence beyond the fact "of a certain resemblance between the sporangiocarp in the one case and the sporocarp in the other," which he says "would tend to confirm the correctness of the reference." Baccarini (2) referred these sporangial types to the Mortierellaceae. Bucholtz (3) was unwilling to accept this view based upon the incomplete information available. Thaxter (7) reviewed the evidence for and against such a procedure but retained them in the genus *Endogone*, suggesting that they were as well placed there as elsewhere until we knew more concerning them. Miss Walker (8) who grew *E. malleola* in culture, describes fully the development and pointed out the resemblance between it and characters of the genus *Mortierella*. This likeness is based largely upon the absence of columellae in *Mortierella* species and in *E. malleola*. Since no sexual stage has been reported for either of the sporangiocarpic species, it is impossible to determine with finality the proper disposition of them. Regardless of this difficulty, it is apparent from the data presented here concerning the sporangial stage of *E. sphagnophila* that they should no longer be included in the

genus *Endogone*, in which sporangia of a distinctly mucoraceous type are connected with a zygosporic stage. The lack of columellae and the absence of known sexual stages sets the two species definitely apart from the genus *Endogone*. A new genus *Modicella*⁴ is therefore proposed for them. Until more is known concerning the sexual development, it should be placed in the Mortierellaceae.

The position of the genus *Endogone* in the Phycomycetes is already generally accepted by most mycologists. Bucholtz (3), and Atkinson (1) in their studies of the genus have shown that the type of sexual reproduction is similar to that known in the zygomycetes. Bucholtz considered the type of conjugation sufficiently distinct from that known in the established families of the Mucorales, and so proposed the new family Endogonaceae. He recognized the close affinity of this with the Mucoraceae. The presence of the *Mucor*-like sporangia that have been discovered in *E. sphagnophila* confirms this opinion.

The presence of chlamydospores in both species investigated is also of significance. That this type of spore was found so abundantly in culture was not surprising when judged in the light of our understanding of the reactions of other phycomycetes in culture. Throughout this group the formation of exceptionally large numbers of chlamydospores is taken as fair proof of unfavorable cultural conditions. As has been pointed out previously, the conditions maintained in culture were obviously not optimum for the fungus. The fact that in certain species in the genus chlamydospores are the only type known indicates that they are to be expected as representing a significant part of the developmental cycle. It is quite possible that some of these chlamydosporic forms may be found to belong to the zygosporic species already described or not yet discovered. The wall structure in the chlamydospores in these species differs from what is commonly found in other Mucorales. A single wall is the rule elsewhere, while in these two species two walls are found in

⁴ *Modicella* gen. nov.

Sporangia globosa, 40-70 μ , intra miculas intextarum hyphorum; miculae plusminusve stipitatae; columellae deficientes; sporangiosporae numerosas, globosae, hyalinae, 7 μ ; zygosporae no visae.

Species typicum *Endogone malleola* Hark.

mature chlamydospores. It is not easy to demonstrate their presence in all spores, and the fact that the inner one is frequently very slowly formed only adds to the difficulty. However, in the genus *Glaziella*, in the Endogonaceae, the chlamydospores are described as having two distinct walls, so that it seems that in this family of the Mucorales there is a departure from the usual condition.

E. sphagnophila is shown to be a homothallic species from the fact that the complete life cycle was developed from a single sporangiospore, and also from the fact that both suspensors arise from the same hypha as was seen in the young zygospores forming in sporocarps on sphagnum (FIG. 20, 21).

Thanks are gratefully acknowledged to Dr. E. B. Mains for helpful criticism and for the photographs.

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TECHNICAL DESCRIPTIONS

ENDOGONE Link, 1809. Emmended

(Revision adapted from description by Thaxter)

Fructification epigaeous or hypogaeous, producing thick-walled isogamous or heterogamous zygospores with or without specialized envelopes; thick-walled acrogenous non-sexual chlamydospores; sporangia with definite columellae. The zygospores and chlamydospores usually produced separately in compact groups; surrounded by a variably developed pseudoperidium or tomentum usually forming a definite sporocarp.

ENDOGONE OCCIDENTALIS Kanouse

Fructification sessile, subglobose, flattened, 2-4 mm. in diameter, gleba firm, yellowish, hyphae thin-walled, vesicular, peridium of tightly pressed hyphae forming a tomentum when fresh and appearing as a scaly covering when dry. "Apricot yellow" fading to "pale pinkish buff" when dry; zygospores distributed irregularly, broadly ovoid to irregularly spherical, $35-47 \times 50-60$ or $40-50 \mu$, walls $6-12 \mu$ thick, lamellate endospore continuous, contents homogeneous, colored bright orange; chlamydospores (in culture) spherical $40-60$ (100) μ , intercalary, surrounded by 2 walls.

Type collected on chips and other debris partially buried in

soil at base of very rotten coniferous stump, Lake Quinault, Washington, Oct. 23, 1925 C. H. Kauffman (type); Lake Quinault, Nov. 1925 C. A. Brown, on Douglas fir, Takilma, Ore. Nov. 29, 1925 C. A. Brown. Type deposited in the Herbarium of the University of Michigan.

This species differs from *E. sphagnophila* in habitat, in absence of sporangia in culture, in smaller size and paler color of the sporocarps.

EXPLANATION OF PLATE

Fig. 1, sporocarp of *Endogone sphagnophila* Atk. growing on sphagnum; greatly enlarged; 2 and 3, photomicrographs of zygospores taken from a sporocarp; 4, *Endogone pisiformis* Link. Natural size reproduction of the two original illustrations published by Link in 1809.

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THE AMANITAE OF WASHINGTON

J. W. HOTSON

(WITH 4 FIGURES)

The literature dealing with the Agaricaceae of Washington is rather meager and the field relatively new. In 1922 when Dr. C. H. Kauffman visited this state on a mycological trip he made the remark that "the collector is astonished—nay, somewhat alarmed at his ignorance—to find so many (mushrooms) that appear to be undescribed." During the same visit he made another significant statement that "as a rule the mushrooms of Western Washington and Oregon are Friesian or new," indicating that our forms are more like those found in Sweden than those of eastern United States. Of late years, in the Puget Sound region, considerable interest has centered around edible mushrooms—a condition probably stimulated at least in part, by the present depression and the desire of many people to help to solve the rather serious problem of food supply. Intimately associated with the collection of edible species is the necessity of a knowledge of those forms which are poisonous. Among the latter group none has received more attention than the members of the genus *Amanita*, not only because this genus contains the most deadly of all the mushrooms but also because a number of rather serious cases of mushroom poisoning has resulted locally, from the eating of some of these poisonous forms in mistake for edible ones (2).

The object of this paper is to bring together the various species of the genus *Amanita* that have been reported for Washington. Some few are added which are not as yet reported for this region but have been reported for western Oregon and probably do occur here.

The genus *Amanita* comprises those white-spored forms which have an annulus, a volva, free gills or attached by a line, and a stem readily separable from the pileus. Most of these species are poisonous and are found growing on the ground in woods, in thickets, or under trees in more or less open spaces, sometimes in

fields or on lawns. Since the mycelium is perennial the sporophores or fruit-bodies are likely to be found in the same locality from year to year. In some species the universal veil splits above the pileus and during the enlargement of the fruit-body, slips off leaving the pileus glabrous or nearly so and forming a more or less cup-like volva—the death cup—at the base of the stem, the margin of which extending some distance above the bulb. In other species the universal veil splits by a circular line between the bulb and pileus, leaving remnants on the surface of the pileus as floccose scales, warts, or loose friable patches extending practically over the whole fruit-body. In the following key the first division is made on this characteristic of the volva.

KEY TO THE SPECIES OF AMANITA

- A. Volva persistent forming a cup-like structure at the base of the stem, its upper part free from the stem or merely collapsing on it.
 - B. Pileus orange-red or yellow.
 - C. Pileus orange-red to orange-yellow, 8–20 cm. broad.
 - 1. *A. caesarea* Fries
 - CC. Pileus without orange or red shades.
 - D. Spores globose or sub-globose; pileus honey-yellow or straw-colored, umbonate, the umbo yellowish becoming umbrinous.....2. *A. umbrinidisca* Murr.
 - DD. Spores elliptical.
 - E. Pileus yellowish or yellowish-brown, tinged with green.
 - 3. *A. calypttrata* Peck
 - EE. Pileus not tinged green.
 - 4. *A. calyptroderma* Atk. & Ball
 - BB. Pileus not orange nor yellow.
 - F. Pileus pure white, margin of the pileus even.
 - G. Pileus conical when young; annulus rarely formed.
 - 5. *A. virosa* Fries
 - GG. Pileus convex then expanded; annulus normal.
 - 5. *A. verna* Fries
 - FF. Pileus brown or grayish-brown.
 - H. Margin striate.....4. *A. calyptroderma* Atk. & Ball
 - HH. Margin not striate; pileus viscid, glabrous or with a few remnants of scales.....5. *A. phalloides* Fries
 - AA. Volva splitting in a circular line between the bulb and pileus (circumscissile) and forming an abrupt inrolled sheath or several imperfect rings.
 - I. Pileus yellowish, sometimes orange or orange-red.
 - J. Pileus striate.
 - K. Pileus 8–20 cm. broad usually orange or orange-red; sometimes lemon-yellow; bulb with concentric scales or rings.
 - 6. *A. muscaria* Fries

- KK. Pileus 3-11 cm. broad; bulb without concentric scales or rings.
 L. Spores globose 8-9 μ in diam.; pileus 3-8 cm. broad, usually white, sometimes slightly tinted yellow or tawny-olive at the center 7. *A. cothurnata* Atk.
 LL. Spores elliptical 10-12 \times 7-8 μ ; pileus pale-yellow 5-11 cm. broad 8. *A. junquillea* Quél.
- JJ. Pileus not striate.
 M. Bulb conspicuously marginate-depressed, 2-3 cm. broad; pileus 4-8 cm. broad 14. *A. Mappa* Fries
 MM. Bulb rounded, not marginate-depressed.
 N. Pileus 8-20 cm. broad 6. *A. muscaria* Fries
 NN. Pileus up to 6 cm. broad . . . 9. *A. praegemmata* Murr.
- II. Pileus not yellow nor yellowish.
 O. Base of the stem more or less deeply rooted.
 P. Odor strong of chlorine or chloride of lime.
 10. *A. chlorinosma* Peck
 PP. Odor not strong of chlorine or chloride of lime.
 11. *A. solitaria* Fries
- OO. Base of stem rounded, not root-like.
 Q. Pileus white or whitish.
 R. Margin of the pileus finely striate when mature, sometimes darker at the center . . . 7. *A. cothurnata* Atk.
 RR. Margin of the pileus not striate, persistently incurved; the whole plant pure white. . . 12. *A. silvicola* Kauff.
 QQ. Pileus gray, brownish-gray or smoky-brown.
 S. Spores globose 8-9 μ ; bulb marginate-depressed; margin of the pileus even.
 T. Annulus median or inferior; cap and stem covered by an ashy-colored pulverulence.
 13. *A. tomentella* Kromb.
 TT. Annulus superior 14. *A. Mappa* Fries
 SS. Spores elliptical 10-12 \times 7-9 μ ; margin of pileus obscurely striate; bulb subspherical.
 15. *A. pantherina* Fries

1. AMANITA CAESAREA Fries

This beautiful, large, orange-red mushroom which is one of the most attractive of the whole group has rarely been found in Washington. It has been collected on two different occasions in the Black Hills, west of Olympia. It is readily recognized by the large size and bright color of the pileus which is striate and glabrous at maturity and also by the prominent, white, sac-like volva. Even in the button stage it is easily distinguished by its close resemblance in size, shape, and color to a hen's-egg. It is not poisonous.

2. *AMANITA UMBRINIDISCA* Murr.

Syn. *Venenarius umbrinidiscus* Murr.

The type specimen of this species was collected by Murrill in the fall of 1911 in a fir forest near Seattle (7). The yellowish umbo becoming umbrinous at maturity, the conspicuous long-striate margin, and the large subglobose spores (7-9 μ) are the most striking characteristics.

3. *AMANITA CALYPTRATA* Peck

The type specimen of *A. calyptрата* was collected in Oregon in 1900. It has also been found in the vicinity of Seattle under Douglas fir. It can be readily recognized by the large size of the pileus (10-20 cm. broad), the greenish tinge that pervades the whole fruit-body, and "by the large persistent patch of grayish-white felty material that covers the center of the pileus and sometimes extends nearly to the margin." It is not poisonous.

4. *AMANITA CALYPTRODERMA* Atk. & Ball.

Syn. *Amanita calyptratoides* Peck (10)

This species has been collected in the vicinity of Seattle but is apparently rather rare in Washington. It is however, more common in Oregon where it has been collected by Kauffman (6) in the Siskiyou Mountains and by Zeller (10) in the woods near Corvallis. As the name implies, this species resembles closely *A. calyptрата* Peck. It differs, however, in the absence of the greenish tint in the pileus, gills, and stem, also in the presence of striae on the upper part of the stem, and in the thick double volva at the base.

5. *AMANITA PHALLOIDES* Fries

In this state, *Amanita phalloides* has been found only a few times. It has been collected in the vicinity of Olympia, Centralia, and in the Cascade and Olympic mountains by Mrs. Maude E. Morris. All of these specimens were of the umber-brown to smoky-olive type with the margin of the volva free and torn—not circumscissile. The brownish stems have a polished appearance when young, but break up and become roughened in age. As a rule our plants are not as large as the described type, being about 6-8 cm. broad with slender stems.

Closely related to *A. phalloides* are *A. verna* and *A. virosa*, all three apparently containing the same poisonous activating principle. They are all about the same size, with the pileus viscid, the margin even, the gills free or adnexed by a line, and the spores apiculate. The spores, however, are slightly smaller in *A. virosa*. The sporophores of the latter are more or less conical when young, while those of the other two are convex becoming expanded. The pileus and the stem of both *A. verna* and *A. virosa* are pure white while in *A. phalloides* the pileus is umber-brown or smoky-olive. At times, however, the margin in the latter becomes whitish but never pure white. The annulus of *A. phalloides* is similar to that of *A. verna* but in *A. virosa* it is evanescent. The writer has found neither of the last two in Washington.

6. AMANITA MUSCARIA Fries (FIG. 1)

The bright-scarlet pileus, spotted with white patches makes *A. muscaria* a fair rival of *A. caesarea* for first place among our mushrooms for beauty and attractiveness. It is widely distributed throughout the Puget Sound region in various types of soil and under both coniferous and deciduous trees. It has been collected in and around Seattle, Tacoma, Olympia, Kirkland, Summit, Grays Harbor and on Bainbridge Island.

Besides the bright-scarlet European type there is a form resembling that found in eastern United States. This is a handsome-looking mushroom with lemon-yellow to pale-yellow pileus bedecked with white or yellowish-white scales. Up to the time Dr. Jakob E. Lange of Denmark visited the Pacific Coast on a mycological trip in 1931 this form was considered the *formosa* variety of the European species. A recent letter from Dr. S. M. Zeller who was in close touch with Dr. Lange while here, says in part, "Dr. Lange believes it (the lemon-yellow variety of *A. muscaria* found along the Pacific Coast) is different from anything in Europe including the named varieties. Until he made this statement I was hoping that we could use the name *A. formosa* and raise it to specific rank, but I think Dr. Lange knows the European forms well enough to take his word for it." Both Dr. Lange and Dr. Zeller are inclined to consider our yellow form

as a new species and identical with the form commonly found in the eastern United States. More careful study, however, is necessary before coming to a definite decision on this point.

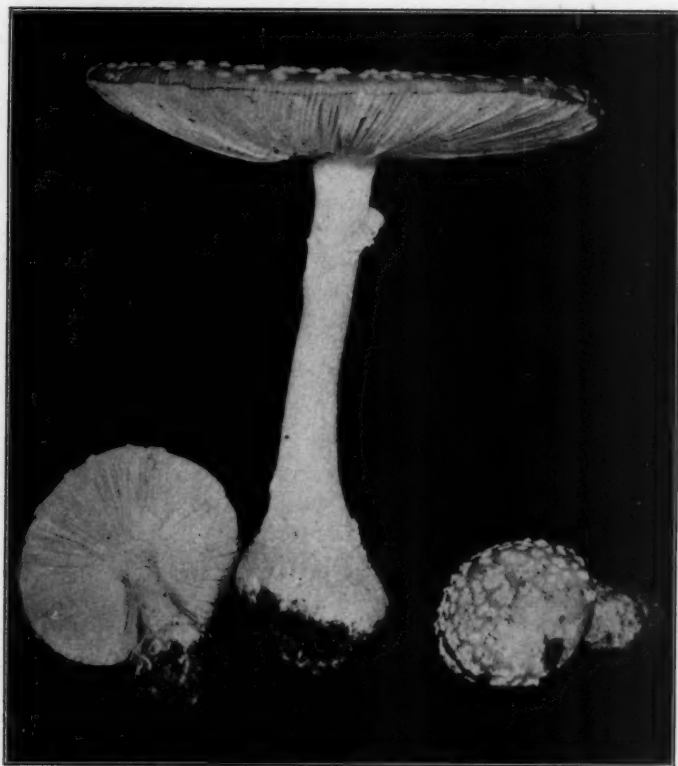


FIG. 1. The lemon-yellow variety of *A. muscaria*.

Another variety, *umbrina* has a brown or umber-colored pileus, approaching *A. pantherina* in general appearance, but it may be distinguished by its yellowish stem which is most pronounced above the annulus. It has been collected along Denny Creek near Snoqualmie Pass.



FIG. 2. A, *Amanita junquillea*; B, *Amanita chlorionosma* showing the dense white floccose structure of the veil; photo by C. F. Todd.

7. *AMANITA COTHURNATA* Atk.

This species has been reported from the vicinity of Seattle, Bremerton, and Keyport but rather infrequently. Like many other *Amanitas* the color of the pileus varies considerably. When pure white, it is readily distinguished by the finely striate margin of the pileus, but sometimes the center is tinged yellow or even tawny-olive in which case it might be confused with *A. pantherina*. It may be distinguished from the latter, however, by the character of the spores which are smaller and globose ($8-9\ \mu$ in diameter). Some interesting specimens of the pale-yellow type with brownish-tinted centers resembling the light-colored forms of *A. pantherina* have been collected by Mrs. Maude E. Morris. The gills of these specimens are definitely serrulate. For illustrations of the gills, the upper surface of the pileus, and the volva see Ref. 7.

8. *AMANITA JUNQUILLEA* Quél. (FIG. 2A)

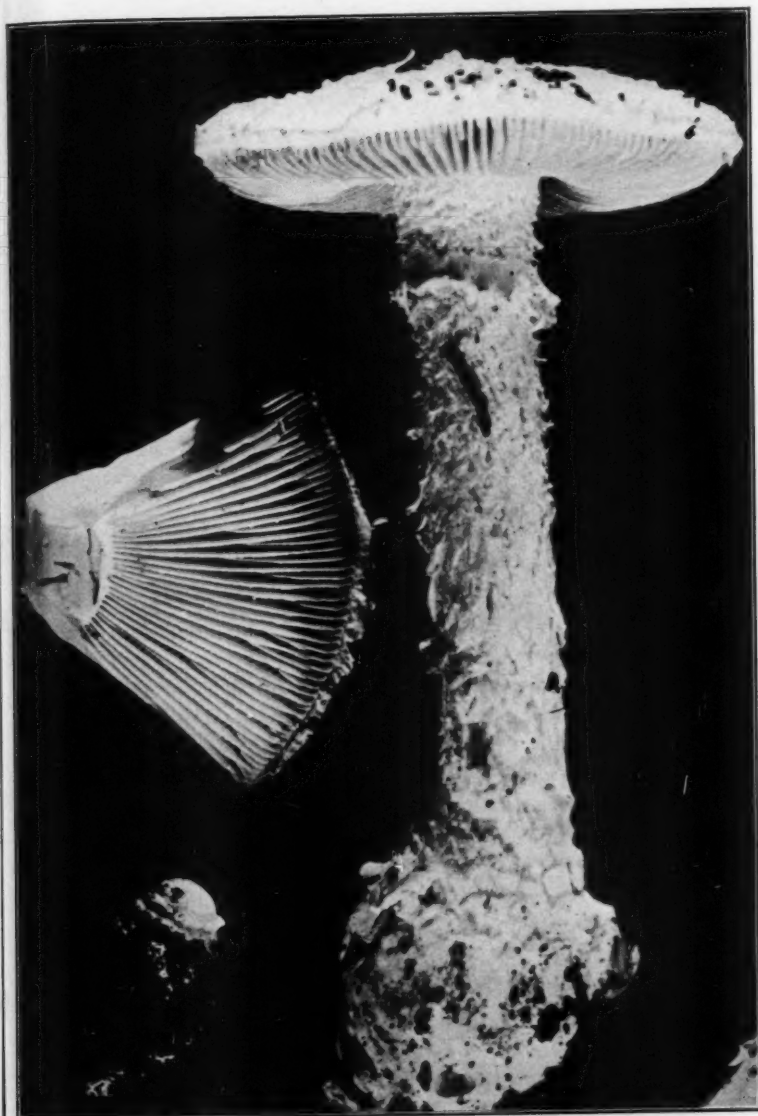
In Washington *Amanita junquillea* has been collected on the University campus, Fort Lawton, in the Cascade Mountains near Summit, and quite abundantly on the open "prairies" around Olympia where the soil is composed of black silt and humus. Kauffman (5) reported this species from Mt. Hood, Oregon, in 1922. Our western species follows quite closely the description of the European form as given by Ricken (9), the spores measuring $10-12 \times 7-8\ \mu$.

This species may be recognized by the pale yellow-buff pileus (5-9 cm. broad), covered with white patches of the universal veil, the striate margin which exceeds the gills, and the size of the spores.

9. *AMANITA PRAEGEMMATA* Murr.

Syn. *Venenarius praegemmatum* Murr.

The type specimen of *A. praegemmata* was collected by Murrill in 1911 "on sandy soil in open woods near Seattle." It was also collected at Coos Bay, Oregon. Murrill states that "fresh specimens suggest one of the honey-colored forms of *A. muscaria* and the dried specimens are not very different from small plants of *A. rubescens*." This species has not been found by the writer.

FIG. 3. *Amanita solitaria*.

10. *AMANITA CHLORINOSMA* Peck (FIG. 2B)

This species has been collected in the vicinity of Seattle and Olympia. When once found one can nearly always depend on finding it in the same locality for several seasons. When growing in deep, dark woods where the sun does not penetrate, our plants fit rather closely the description given by Kauffman (4 p. 615). In open woods on gravelly soil like that east of Olympia, the specimens might easily be mistaken for *A. solitaria* as the pileus then is grayish-brown with harder, more warty scales.

Since *A. chlorinosma* is so variable, many authors have had difficulty in distinguishing it from *A. solitaria* and *A. strobiliformis*. Until some of these discrepancies are cleared up by further study, it would seem best to follow Kauffman's suggestion (4 p. 616) and refer all out forms, which have a strong penetrating odor of chlorine or chloride of lime, to the species *A. chlorinosma*.

11. *AMANITA SOLITARIA* Fries (FIG. 3)

Amanita strobiliformis Yitt.

In western Washington *A. solitaria* has been found rather infrequently around Seattle, Edmonds, Steilacoom, and Duvall, in deep coniferous woods. Sometimes after hard, prolonged rains, all the volva patches wash off leaving the pileus smooth. The pileus then feels like wet kid leather. The gills of our plants are minutely crenulate on the edge as shown in figure 3. This is in accord with the description given by Rea for the European species but Kauffman describes them as "even" while Atkinson states that "the edges are often floccose where they are torn from the slight union with the upper surface of the veil." Because of the great variation in this species, some authors, including Kauffman, Bresadola and Atkinson, (4 p. 615) consider *A. solitaria* and *A. strobiliformis* as identical assuming that the variations occurring in the scales on the pileus and stem and in the shape of the bulb and stem, are not sufficient to warrant forming two species. The writer is inclined to accept this interpretation until further investigation demonstrates that a different view is preferable.

12. AMANITA SILVICOLA Kauff.

The pileus of *A. silvicola* is 6–12 cm. broad, pure white, floccose but not forming firm warts, and not striate, the gills are free or decurrent by a line, sometimes approaching an adnate condition. There is no odor or taste. The spores are elliptical, smooth, obliquely apiculate, measuring $9-10 \times 5-5.5 \mu$. The type specimen was collected by Kauffman on Mt. Hood, Oregon in 1922 (5). In Washington it has been found quite frequently in the fall along road-sides or in coniferous woods. It has been collected on the "prairies" around Olympia and Tacoma, as well as in the vicinity of Seattle, Kirkland, Edmonds, Everett, Stevens Pass, and Grays Harbor. When growing on the "prairies" where there is considerable black silt in the soil, it is almost dark-gray in color due to the fine dark silt adhering to the fluffy pileus. This locality seems to be especially well suited for its growth for it is found abundantly and often in dense clusters of five or six in a group. Occasionally one will be found with a root-like extension somewhat similar to *A. solitaria*. In extreme age the pileus of *A. silvicola* develops bright rose-colored spots and streaks, the beginning of decay. It resembles *A. chlorinosma*, *A. cothurnata*, and *A. solitaria* in having a pure white sporophore and a loose-fitting sheath-like volva. Of these species the first may be easily distinguished by its characteristic penetrating odor of chlorine or chloride of lime; the second by the striate margin of the pileus; and the third by its rooting bulb, the firm warty scales on the pileus, the broader spores, and the character of the universal veil.

13. AMANITA TOMENTELLA Kromb.

Kauffman (5) collected this species on Mt. Hood, Oregon, in the autumn of 1922 in a hemlock and cedar forest. The writer has not found it in Washington but it probably is here. Kauffman referring to this species (4 p. 607) says: "It is easily known by the ashy-colored pulverulence on cap and stem, and the median, pendant annulus. The main color of the pileus varies from umber-brown to drab, with an obscure tinge of lilac, or purplish." The margin of the pileus is not striate.

14. AMANITA MAPPA Fries (FIG. 4)

The smoky or grayish type of *A. Mappa* as described by Kauffman (4 p. 609) is quite common in the vicinity of Seattle. Although usually solitary, sometimes six or eight specimens may occur fairly close together in a single group. It apparently obtains a maximum development in moderately dry, well-shaded, second-growth stands of conifers. The pileus is silky, grayish or grayish-brown bearing a few rather large, irregular, floccose, whitish patches on the top. The circumssile volva and the large spherical, marginate-depressed bulb are usually sufficient to distinguish this species from closely related forms such as *A. phalloides*. These facts, however, are not sufficient to distinguish it from *A. tomentella* as described by Kauffman. The size of the pileus, the shape and size of the spores are practically the same in both species. The main differences between them seem to be the lilac or purplish tinge of the pileus in *A. tomentella*, and the position of the annulus which is superior in *A. Mappa* and median or inferior in *A. tomentella*. Although the annulus of *A. Mappa* is usually superior as illustrated by Atkinson (Fig. 58, p. 58 "Mushrooms," under *A. phalloides*), yet not infrequently, as is shown in Fig. 4 of this article, it is nearly median. This fact is also brought out by the illustrations of this species by Brasodola (Vol. 1, Tab. 7) and by Ricken (Taf. 77: Fig. 2). Some authors consider the smoky or grayish type of *A. Mappa* as a variety of *A. phalloides* just as *A. tomentella* is regarded as a variety of *A. porphyria*. There are several points in which these closely related forms need further investigation especially in the field. It is possible that a different disposition of this type of *A. Mappa* and *A. tomentella* may be desirable when additional information is obtained.

15. AMANITA PANTHERINA Fries

Syn. Amanita pantherinoides Murr.

Of late years not a little confusion has arisen over the relation of *A. pantherina* Fries to *A. pantherinoides* Murr. In a previous paper (3) these two species have been shown to be identical hence *A. pantherinoides* is here considered as a synonym.

This species is widely distributed over western Washington having been collected at Anacortes, Seattle, Tacoma, Fort Lewis, Mt. Rainier, Nisqually Valley, and Grays Harbor. Zeller reports it from Corvallis, Oregon. It has been found most abundantly



FIG. 14. *Amanita Mappa*.

on the Tacoma "prairies" and around Fort Lewis under young Douglas fir trees. Often the collections made in the spring and in the fall were from under the same tree. It has been shown to be poisonous (2). Many cases of mushroom poisoning have been reported both in the spring and in the fall.

The color of the pileus of *A. pantherina* varies considerably. Besides the typical brownish or cinnamon-brown form, yellowish or yellowish-brown variations occur. These light-colored specimens resemble closely similar forms of *A. cothurnata* and the two might be easily confused, the chief distinction being the size of the spores. To add to this confusion the writer has found, as

Beardslee has (1), that in dried specimens, especially if they have been dried rapidly, the outside wall of some spores break away so that the large spherical globule, so conspicuous in the fresh material, is seen free, and often swells somewhat in the water. These structures when examined, would readily fit the description of the spores given for *A. cothurnata* namely, "globose, 8-9 μ in diameter." Further work is contemplated on the relationship of these two species whenever material is available.

The writer is indebted to Mrs. Maude E. Morris for valuable suggestions in connection with the preparation of this paper, and also to Mr. C. F. Todd for the photograph of Figure 2B and to Mr. D. E. Stuntz for several of the other photographs.

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SPORANGIA OF A PHYCOMYCETE IN VESSELS OF PHILODENDRON RIGIDIFOLIUM

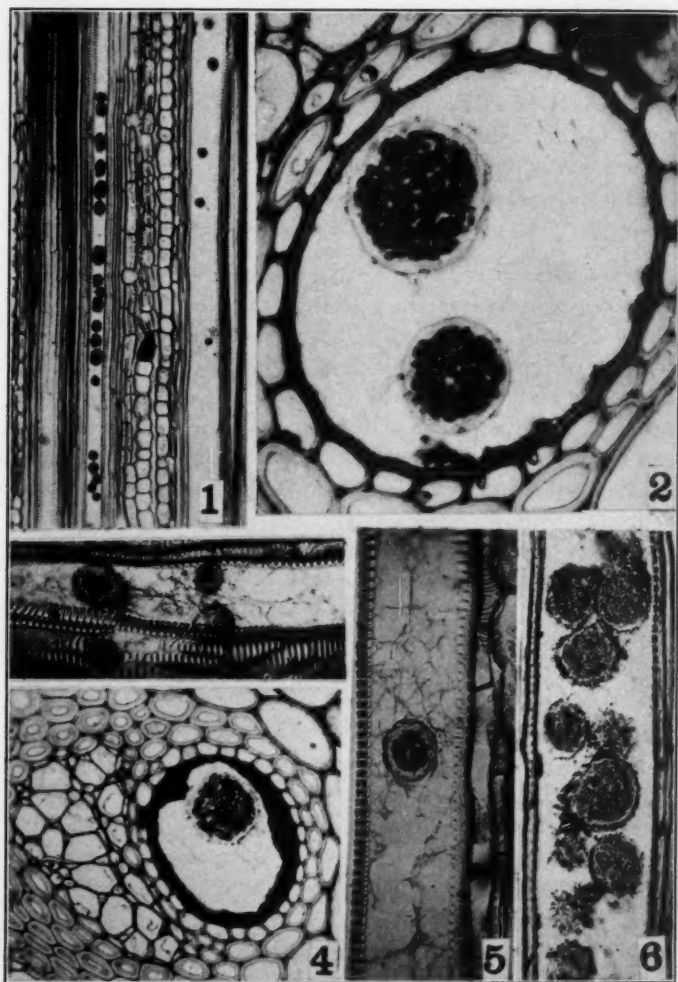
ROBERT H. WOODWORTH

(WITH 6 FIGURES)

Philodendron rigidifolium Krause is a creeping epiphytic aroid. It is endemic being known only from the vicinity of the Canal Zone. Locally it is called "cinchadora" probably because of some astringent principle or possibly because of its skunk-like odor. Its leaves are applied as poultices to snake bites. The plant bears several non-peltate, imperforate, entire, broadly ovate leaves with winged petioles. The flowers are monoecious, the pistillate being on the lower part of the spadix, the staminate above and with separate stamens. The specimens discussed in this paper were collected on Barro Colorado Island by R. H. Wetmore and the writer in July 1929.

The internal anatomy is of the monocotyledonous type. The stem is densely packed with vascular bundles each containing a large solitary vessel of about 1.3 mm. diameter, and about 16 sieve tubes (FIG. 4). The bundles are sheathed by sclerenchymatous tissue. While making a routine examination of the internal morphology of many tropical plants, peculiar structures were noted in the vessels. Subsequent examination of carefully prepared sections of this stem showed the bodies in question to be sporangia of some fungus. As they are in the vessels, longitudinal sections show their distribution to best advantage. Figure 1 shows a number of sporangia in one of the smaller vessels and a few scattered sporangia in a larger vessel to the right. Occasional vessels are heavily infested, others have only a few sporangia, while still others have none.

Figure 2 shows a cross section of a vessel with two of the sporangia in the lumen. The wall of the sporangium has some appreciable thickness and the spores with their nuclei are readily seen. Some of the vessels contain deposits of gum-like substance



FIGS. 1-6. Photomicrographs of sections of stem of *Philodendron rigidifolium*. 1, longitudinal section showing sporangia in vessels, $\times 60$; 2, cross section showing two sporangia within a vessel (nuclei of the spores can be seen, $\times 750$); 3, longitudinal section showing dense hyphae and several sporangia within the vessels, $\times 130$; 4, cross section of a vessel containing peripheral deposit of dark staining substance and a sporangium, $\times 290$; 5, longitudinal section of vessel with one sporangium and network of hyphae, $\times 180$; 6, longitudinal section of vessel packed with sporangia several of which have broken open, $\times 200$.

as in figure 4. This was apparently present in the vessels before infection because in several cases where the vessels were occluded by it sporangia were formed adjacent to the occluding masses, but none were seen within this material.

In most sections from preserved specimens of this stem the hyphae are diffuse and not easily studied because of their small size. In some few cases hyphae are in great abundance as in figures 3 and 5. Since it is not possible in photomicrography to obtain any considerable depth of focus the density of the hyphal mass is not recorded. The fungal threads pass through the pits in the vessel walls, ramify through the lignified cells of the bundle sheath and penetrate the parenchyma cells of the fundamental tissue. No hyphae have been seen in the phloem cells. Apparently sporangia form only in the vessels. In some cases the sporangia may be almost large enough to occlude the vessel (FIG. 3); more often they have a diameter of from one-quarter to one-half that of the vessel. The spores measure 3×4 microns. Small sporangia contain a dozen or more spores while large ones form several hundreds.

The question early arose as to whether the fungus was in the plant when it was collected or whether it might possibly have penetrated the plant tissues after collection. Representative parts for herbarium specimens and for anatomical study were selected from plants which appeared to be quite normal and healthy. The stems were cut into one foot lengths, tied together and numbered. Collections were made in the morning and were worked over in the afternoon. Material for preservation therefore rested from two to six hours before being cut into small cubes, tied in cheese cloth bags and placed in a 1 per cent chromoacetic acid solution where it remained for twenty-four hours. After this it was washed in water for twenty-four hours, then placed in form-alcohol (5 per cent formalin, 50 per cent ethyl alcohol) where it remained for some months. Specimens for herbarium sheets were treated in the usual manner and the presses placed in a drying closet containing oil heaters. Naphthalene flakes were sprinkled on the dry plants before bundling. The fungous sporangia under discussion are found not only in the preserved material but also in the dried herbarium specimens.

It does not seem, even in the warm and humid atmosphere of Panama, that a fungus could possibly grow fast enough to penetrate the whole stem and then form large numbers of sporangia in the few hours between collection and preservation. Among hundreds of specimens of other plant species nothing similar to this has been seen even in other species of the genus *Philodendron*. It appears to be a reasonable assumption that this organism is a parasitic fungus.

The relationship between host and parasite should receive further study in order to determine its full biological significance. In this connection attention is called to the epiphytic habit of the host. Parasitic fungi are commonly in soil and they enter plants through the root system. This host has no roots in the soil. It is possible that the fungous spores are carried by some insect as is the case with many well known pathogenic fungi. Such a spore carrying insect while feeding on the plant or sucking its juices could cause inoculation. The formation of the fungous sporangia within the vessels, and of course therefore in water, suggests a means of rapid spread through the plant. If the sporangia break open within the plant the spores could easily be carried about by the transpiration stream thus spreading the parasitic organism much faster than it could grow. Figure 6 shows eleven sporangia four of which appear to have released their spores. Many similar cases have been observed. Sporangia are occasionally cut open by the microtome knife but when this has occurred the spores all float away during the process of slide making. In those sporangia which seem to have been naturally broken the mass was imbedded by the celloidin. Possibly the sporangia do not break and release spores until the plant decomposes.

Attempts to cause the germination and growth of the spores from stems of herbarium specimens have proved unsuccessful. This is not surprising because parasitic fungi of this type are notoriously difficult to culture. Furthermore the spores have been desiccated and subjected to continuous naphthalene vapors for over five years.

Because no living material is available it is not possible to place this fungus in its proper taxonomic group with any degree of certainty. The characters of the hyphae, for instance, in the

killed and fixed material may be quite unlike those of the living organism. Several competent mycologists have suggested that the fungus may be a member of the filamentous Chytridiales or the Mucoraceae. If the former it is an unusual species in that the host is a vascular plant. It is hoped that this report will focus attention on what appears to be a most interesting organism.

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A NEW IMPERFECT FUNGUS

A. G. PLAKIDAS AND C. W. EDGERTON

(WITH 1 FIGURE)

While making a study of the organisms associated with a root and collar rot of pear trees in Louisiana, a fungus with very characteristic spores was isolated from the dead bark. This fungus apparently does not fit in any of the described genera of fungi and consequently a new genus is erected for it.

The outstanding peculiarity of this fungus is the form of the conidia. These are wedge-shaped with very deep constrictions and resemble the common illustrations of Christmas trees (FIG. 1, *A, B, C, D*). The conidia are hyaline and two-celled. When viewed from the edge, they are seen to be flattened to slightly convex on one side and flattened to slightly concave on the other. The septum occurs just above the basal lobes. The conidium is borne on a slender stalk and when detached, approximately one-half of the stalk remains attached to the spore as a pedicel, while the other half remains on the conidiophore as a sterigma (FIG. 1 *C*).

The conidiophores arise as branches of hyphae and are at first short and somewhat thickened, but later elongate and become of approximately the same thickness as the mycelial threads. They are hyaline, septate, often branched and very variable in length. Each conidiophore, or its branch, bears a variable number of conidia (1-6 noted). A conidium starts to develop near the apex of the conidiophore, but it is pushed aside as the latter continues to grow and becomes lateral. The youngest spores consequently are those nearest the apex of the conidiophore.

In pure cultures, the young mycelial threads are hyaline, septate, creeping and closely appressed to the agar surface. The older threads thicken and become closely septate and brown in color, giving the cells a chlamydospore-like appearance. On still older cultures, the aerial growth may almost disappear and the

surface of the colony becomes dark and leathery. The conidia germinate readily and the fungus makes a satisfactory, though rather slow growth, on a variety of media. In a number of tests at room temperature, the average diameter of 8-day colonies was 17.6 mm. on beanpod agar, 20.00 mm. on dextrose agar, and 25.2 on Czapek's agar. The fungus sporulates very profusely on all the media tried, the spores usually beginning to form after about two days. In older cultures conidia are not very abundant.

Classification: The fungus belongs in the order Moniliales (Hyphomycetes) of the Fungi Imperfecti, and on account of the septate condition of the spores would have to be placed in the Moniliaceae-Hyalodidymae group. The fungus, however, seems to resemble more closely certain of the organisms with single-celled spores found in the group, Moniliaceae-Hyalosporae, such as *Physospora* and *Asterophora*.

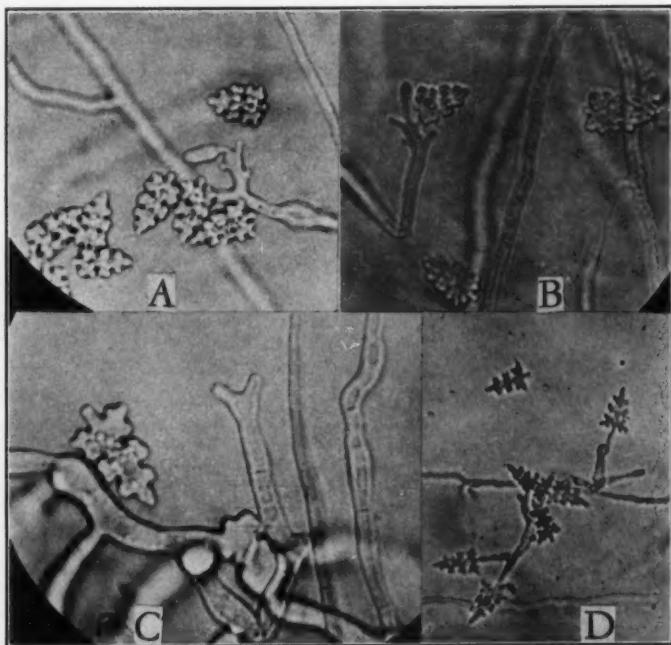


FIG. 1. Conidia and conidiophores of *Dendrosporium lobatum* from agar cultures. A and B, $\times 750$; C, $\times 1200$; D, $\times 420$.

Dendrosporium gen. nov.

Vegetative hyphae septate. Conidiophores similar to vegetative hyphae, variable in length, septate, often branched, with sterigmata near the apex. Conidia hyaline, flattened, deeply constricted, pedicellate, one-septate, one to several on each conidiophore.

Dendrosporium lobatum sp. nov.

Young colonies on beanpod agar closely appressed at the margins, white to creamy white, centers somewhat raised, aerial growth scanty. Older cultures grayish. Mycelium septate, hyaline when young, later becoming closely septate with brown, swollen cells, chlamydospore-like in appearance. Sporulation profuse in young cultures, very scanty in old cultures. Conidiophores approximately the same thickness and structure as the mycelium, developing as branches from the mycelial threads, septate, branched, very variable in length, hyaline. Conidia hyaline, deeply constricted so that there are usually three lobes on each side, the basal lobes being the largest, flattened to slightly concave or convex, pointed at the apex, pedicellate, uniseptate, the septum just above the basal lobes, the two cells being of unequal size, borne on slender sterigmata, one to several on each conidiophore, $3.4-4.4 \times 6.8-10.2 \times 10.2-15.3 \mu$, average about $3.9 \times 7.8 \times 12.2 \mu$.

Saprophytic, cultured from dead or dying bark of pear, *Pyrus serotina*. Type material in form of dried agar cultures, deposited in Mycological Collections, Bureau of Plant Industry, Washington, D. C.

DEPARTMENT OF BOTANY,
LOUISIANA AGRICULTURAL EXPERIMENT STATION,
BATON ROUGE, LOUISIANA

NOTES AND BRIEF ARTICLES

MYCOLOGIA

SPECIAL OFFER

During the Sixth International Botanical Congress in Amsterdam a special offer was made on back sets of Mycologia as follows: Volumes one to twenty-four were offered at fifty dollars (\$50.00), which is about half price. With every such order a copy of the recently published Twenty-Four Year Index, beautifully bound in red fabrikoid (value three dollars and fifty cents, \$3.50), will be given free. The response to this was so favorable that the Managing-Editor has decided to hold the offer open for a limited time, the time depending on the rate of sales. This is to enable members of the Mycological Society of America, who do not have specimens for exchange, to secure the early volumes at the lowest possible cost. If only a partial set is desired the rate per volume will be the same. Also a reasonable amount of time will be allowed for payment.—FRED J. SEAVER.

A CORRECTION

Since the publication of the name *Sphaerella* (*Mycosphaerella*) *dubia* L. E. Miles (Trans. Ill. Acad. Sci. 10: 250. 1917) antedates the publication of *Mycosphaerella dubia* Wolf (Mycologia 27: 347-356. 1935), it becomes necessary to assign another name to the perfect stage of *Cereospora Rubi*. The name ***Mycosphaerella confusa*** is proposed.—FREDERICK A. WOLF.

FUNGI OF SOUTH AUSTRALIA

Under the title "Toadstools and mushrooms and other larger fungi of South Australia" by J. B. Cleland, the South Australian branch of the British Science Guild has issued an attractive and useful work. Part I, issued in 1934, includes introductory material and the systematic treatment of the Agaricaceae. Part

II, issued in 1935, treats of the remaining Basidiomycetes, exclusive of the rusts and smuts, and, in addition, devotes a few pages to the Ascomycetes and Myxomycetes. The two parts include ten colored plates after paintings by Miss P. Clarke and seventy-seven excellent figures, mainly from photographs, although a number are reproductions in black and white of paintings by Miss Clarke. Complete descriptions are given of 581 species, of which all but seventeen are Basidiomycetes. The parts are sold for five shillings each, less than the cost of publication, and may be had from the Government Printer, Adelaide.—G. W. MARTIN.

LEPIOTA MORGANI IN SOUTHERN CALIFORNIA

The species *Lepiota Morgani* (Peck) Sacc. (*Chlorophyllum molybdites* (Meyers); *Lepiota chlorospora*, Copeland) has been collected during the late summer and autumn for several years in the avocado orchard at the Citrus Experiment Station. This orchard is irrigated but receives no cultivation. In August, 1935, the fungus also developed on the campus of the Citrus Station, and on several of the lawns in Riverside, California. It also was collected several different times on the lawn of the State Hospital at Patton, California.

Lee Bonar, University of California, has recently stated in correspondence with the author, that he has received specimens of *Lepiota Morgani* collected in the vicinity of Los Angeles, Pasadena, and San Diego, but has no record of its occurrence in middle or northern California. The dimensions of the cap of the California fungus were 5–15 cm. The spores in mass were green and the pileus had the irregular scales.

Lepiota Morgani seems to thrive in the warmer climates and is considered by some to be of tropical origin. Under the name *Lepiota chlorospora* it has been listed from the Philippine Islands by Copeland (Ann. Myc. 3: 28, 1905) and was more recently found there by Graff (Mycologia 19: 322–326, 1927). It has been reported by Parks from Tahiti (Univ. of Calif. Publ. Bot. 12: 53, 1926). Murrill (N. Am. Flora 10: 64, 1914) gives its distribution as New Jersey to Iowa and southwest to Arizona, Texas, the West Indies, and Brazil.—CLAYTON O. SMITH.

MORE PAVEMENT BREAKERS

F. J. Seaver recently (*Mycologia* 27: 82-83, 1935) called attention to a report of *Coprinus comatus* ruining tennis courts in England and there have been similar records of fungi breaking up and demolishing pavements and other similar obstructions to their growth, over a period of more than 100 years. Where definitely named, the fungi involved in the several accounts examined have been members of the *Agaricaceae*, notably *Agaricus* and *Coprinus*. A case has recently occurred, however, involving members of the *Lycoperdales* rather than of the *Agaricales*. The condition in question was called to our attention by Mr. Ernest P. Walker, Assistant Director of the National Zoological Park of the Smithsonian Institution, at Washington, D. C. Fungi were found at two points breaking through bituminous macadam pavement which had been laid to a depth of approximately three inches. In the first instance three "eggs" of a phalloid later determined as *Ithyphallus Ravenelii* (Berk & Curt) Fischer were found. The volva of one was broken away to a limited extent, but the others showed no ill effects from their rough treatment of the pavement. Not over fifty feet away a similar break in the pavement revealed the top of a puff-ball, which on closer examination proved to be a moderately sized specimen of *Scleroderma Geaster* Fries. About a square foot of the pavement was disturbed in each case by cracking, and the broken edges forced upward and away from the developing fruiting bodies of the fungi. Due to cool, dry weather prevailing at the time, both fungi failed to complete their development after breaking through the macadam barriers.—JOHN A. STEVENSON.

CHYTRIDIACEOUS FUNGI FROM TWO UNUSUAL SUBSTRATA

In my attempts to find in this country certain peculiar aquatic Phycomycetes described by earlier European investigators, I have been led to an examination of two rather unusual substrata, namely, marine algae and the cast-off larval integuments of certain fresh-water insects. These have been so productive of little-known types that it has seemed worth while to record the occurrence in our country of the fungi found on them. With the

exception of *Chytridium Polysiphoniae* Cohn, none of the species listed here has, to my knowledge, been heretofore recorded from the United States.

MARINE FUNGI

All of these were found in the vicinity of Woods Hole in the course of an investigation carried on at the Woods Hole Oceanographic Institution during the summer of 1934. A full account of this work will be shortly forthcoming.

The following species were found:

FUNGUS	SUBSTRATUM
1. ? (<i>Pleotrachelus</i>) <i>tumaei</i> (Magn.) Peter.....	<i>Ceramium diaphanum</i>
2. ? (<i>Pleotrachelus</i>) <i>sphacellarum</i> (Kny) Peter.....	<i>Sphacellaria radicans</i>
3. ? (<i>Pleotrachelus</i>) <i>Andréei</i> Lghm.....	<i>Ectocarpus siliculosus</i>
4. <i>Rhizophidium globosum</i> (Br.) Schroet.....	<i>Bryopsis plumosa</i>
5. <i>Rhizophidium discinctum</i> Peter.....	<i>Polysiphonia</i> sp.
6. <i>Chytridium Polysiphoniae</i> Cohn.....	<i>Polysiphonia</i> sp.
7. <i>Ectrogella perforans</i> Peter.....	<i>Strialella unipunctata</i> <i>Licmophora Lyngbii</i>
8. <i>Petersenia lobata</i> (Peter.) Sparr.....	<i>Callithamnion roseum</i>
9. <i>Siroldidium Bryopsisidis</i> (de Bruyne) Peter.....	<i>Bryopsis plumosa</i>
10. <i>Pontisma lagenidioides</i> Peter.....	<i>Ceramium diaphanum</i>

FUNGI IN THE INTEGUMENTS OF INSECTS

This material was collected in New Hampshire and on Cape Cod, Mass.

1. *Asterophlyctis sarcoptoides* Peter. (N. H., Mass.).
2. *Rhizoclosmatium globosum* Peter. (N. H., Mass.¹).
3. *Siphonaria variabilis* Peter. (N. H.).
4. *Rhizidium mycophilum* Br. (N. H.¹).
5. *Obelidium mucronatum* Nowak. (Mass.).

On both types of substrata certain forms were observed which have not hitherto been described and hence, will necessitate a full account of their morphology.—F. K. SPARROW, JR.

¹ These two species have been found by me on similar substrata in the vicinity of Cambridge, Eng. during the summer of 1935.

HELVELLA PALUSTRIS IN VIRGINIA

This little known species was described by Peck¹ in 1880 from specimens found growing among mosses and liverworts at Manlius, N. Y., and has apparently been reported but once since, in 1931 by Anderson and Ickis² based upon a single specimen found at Pelham, Mass., which for reasons suggested below is but doubtfully referable to this species. Two specimens recently found by H. A. Allard, in Virginia, in the George Washington National Forest along Hone Quarry Creek (Rockingham Co., Sept. 8, 1935) resemble closely Peck's illustrations and are consistent with his description.

These two specimens are smaller than those described by Peck, but that is scarcely significant. The form of pileus and stipe and the peculiarly straight, sharp and uniform fluting of the stipes in the Virginia specimens agree perfectly with Peck's illustration of these features. The paraphyses and spores look like those in Peck's figure. The spores of the Virginia specimen measure $15-18 \times 11-12 \mu$, and compare favorably with Peck's description and illustrations in the ratio of the two axes although they are somewhat smaller. Peck's description notes ascospores .00065-.0008 \times .0005 in. (i.e. $18.5-20.3 \times 12.7 \mu$). Measurement of the spores in his illustration evaluated in terms of his magnification give $17.5-20 \times 11.2-12.5 \mu$. Through the courtesy of Dr. H. D. House it has been possible to examine ascospores from Peck's original specimens; these spores measured under the same conditions (i.e. in water) $15-20 \times 11-12 \mu$, chiefly, $16-18 \times 11-12 \mu$. All these measurements are quite different as regards the ratio of length to width from that noted by Seaver³ of spores as $9 \times 18 \mu$ and by Anderson and Ickis (l.c.) of $14-18 \times 7-10 \mu$. Seaver (l.c.) has suggested the possibility that Peck's species may be referred to Schaeffer's⁴ *H. pallescens*, a European fungus which is not particularly like *H. palustris* except for flutings of the stipe, which are rounded and not sharp angled, if the evidence afforded by

¹ Peck, C. H. Ann. Rep. N. Y. State Mus. 33: 31, pl. 2, f. 16-18. 1880.

² Anderson, P. J. & Ickis, M. G. Mycologia 13: 201-239. 1921 (pp. 214-215).

³ Seaver, F. J. North American Cup-fungi 247-248. 1928.

⁴ Schaeffer, J. Fung. Bav. et Palat. Icon 4: T. 322. Index, p. 114 (ed. nov. C. H. Persoon), 1780. (Apparently identical with Ed. 1, 1774.)

Schaeffer's original illustration and by several others of more recent date is considered. Rehm,⁵ however, notes spores of $14-16 \times 10-12\mu$ for *H. pallescens* which would be close to those of *H. palustris*. The possibility of referring the New York and Virginia fungus to *H. Queletii* Bres.⁶ as is suggested by Anderson and Ickis for the Massachusetts specimen would appear more pertinent except that this European species possesses filiform paraphyses while those of *H. palustris* are clavate, and the flutings of the stipe as illustrated are less numerous and more rounded rather than sharp edged as in *H. palustris*.

Everything considered it would seem that *H. palustris* Peck, as represented by the original specimens from New York and by Allard's from Virginia is a distinct species and not referable to any known from Europe, justifying Peck's recognition of it as new. Hitherto found only in moist places, it may well be restricted to a particular habitat, but additional gatherings at the correct season should extend its range considerably further.—W. W. DIEHL.

THE GENERA PHILLIPSIA AND COOKEINA

Under the title "The genera *Phillipsia* and *Cookeina* in Netherlands India" K. B. Boedijn (Bull. Jardin Bot. Buitenzorg III. 13: 57-76. 1933) gives an account of his studies on the above genera in the East Indies. It is interesting to note that practically all of the species reported by the writer in North American Cup-fungi are known to occur also in the East Indies. In fact, it is likely that the species of these genera occur in the tropics throughout the world.

Boedijn agrees with the writer in placing these genera in the operculate Pezizaceae instead of with the inoperculate Helotiaceae, as was done by Lindau in Engler and Prantl's *Natürlichen Pflanzenfamilien*. He disagrees with Clements and Shear in uniting the genera *Sarcoscypha* (*Plectania*) and *Cookeina* merely because of a superficial resemblance, since there are marked differences which warrant a separation of the two.

⁵ Rehm, H. *Ascomyceten in Rabenh. Krypt.-Fl.* 2^{te} Aufl. 1: Abt. 3, 1188-1189. 1896.

⁶ Bresadola, J. *Rev. Myc.* 4: 211, 1882; and *Fung. Trident.* 2: 19, T. 92, 1883.

There are certain morphological characters definitely associated with the species of these genera. The first of these is the peculiar striate markings of the spores. Boedijn states "Seaver seems to be the first to have proven its constancy for the above mentioned species." Perhaps it would be better to say that the writer was the first to have called attention to this character. Boedijn claims, however, that the striations are made up of shallow grooves and delicate ridges, which the writer had not been able to observe.

Another character of importance is the eccentrically placed ascostome, which in North American Cup-fungi the writer has referred to as a definite morphological character associated with the species of these genera. Buller in his *Researches on Fungi* (Volume 6: 255) questions this statement, claiming that the eccentricity of the ascostome depends upon the direction of light. Boedijn states "In this connection it may be noted, that on a radial section of a fruitbody all opercula are pointed to the border of the apothecium." Apparently its position neither depends upon the direction of light or on the form of the cup in the plants of these particular genera. In facing the outside of the cup they would have a tendency to scatter the spores rather than to throw them straight up from the surface of the apothecium.

The writer (l.c.) has also noted a great discrepancy between the size of the ascostome and the spore, which has passed through it. Boedijn claims that this apparent discrepancy in size is due to the fact that the writer made post-mortem examinations. He states "The ascusporus, which in living asci is just wide enough for the passing of the spores, shrinks considerably after ejaculation." In another place he states "In two instances only 7 of the spores were ejaculated at once, whereas the remaining spore first stuck in the poremouth and was shot away a short time afterwards. This observation too shows that the ascostome shrinks after spore ejection."

If the ascostome contracts after seven spores have been ejaculated, and is compelled to stretch to allow the remaining spore to pass through, as is indicated by Boedijn (FIG. 5g), how does he know that the ascostome does not contract after each spore ejection, even though the spores appear to pass through in

one series? In fact, Boedijn's own drawings (FIG. 5) indicate the same discrepancy in size between the ascostome, or operculum, and the spore, as was indicated by the writer in North American Cup-fungi.

The statement made by Boedijn that the ascusporus, or ascostome, in living asci is just wide enough for the passing of the spores, but shrinks considerably after ejaculation, is misleading since before the ejaculation of the spores there is no ascostome. Furthermore, the size of the operculum, which usually adheres is an approximate index to the original size of the ascostome, and this is usually not more than half the diameter of the spore. The writer still maintains that this discrepancy in size does exist, and that the expansion and contraction of the ascostome is one of the factors which contributes to the forcible ejaculation of the spores.

Boedijn claims that *Phillipsia gigantea* Seaver is a synonym of *Phillipsia domingensis*, since it differs only in size and intermediate forms have been found. He also claims that *Cookeina tetraspora* does not belong to the genus *Cookeina*, although he does not state to what genus it does belong. The writer noted when this species was described that it did not fit well in the genus *Cookeina*, but it seemed to be the only genus to which it could be referred. It has much in common with other species of *Cookeina*.

The paper is a decided contribution to our knowledge of the species of these two tropical genera, and it is hoped that some student in our own West Indies will continue these studies from fresh material, as has been done by Boedijn in the East Indies.—
FRED J. SEAVER.

REPORT ON THE TAXONOMIC SESSIONS OF THE INTERNATIONAL BOTANICAL CONGRESS

The International Botanical Congress at Amsterdam, as one looks back on it, was marked by a wonderful spirit of coöperation and a desire to stabilize nomenclature. This fact was pointed out by the large number of proposals which amounted mostly to the change of wording that would make clear and more precise the meaning and intent of the existing rules. Therefore, with but few exceptions the points raised were of minor importance and for the most part these were practically decided by the

Executive Committee of the Congress and the Executive Committee of Nomenclature before the meetings, and readily accepted during the meetings.

The matter of nomina specifica conservanda seems to have been fairly definitely settled by the rejection of proposals that were brought forward to validate this procedure. On the other hand, the list of nomina genera conservanda remains to be settled and to this aim it was proposed and carried that names to be conserved before final acceptance by the congress should be submitted to the careful scrutiny of each group of botanists, *i.e.* phanerogamic, cryptogamic which was divided into three subgroups, fungi, algae, and bryophytes, paleobotanic and the like. In this manner the hasty acceptance of genera to be conserved was avoided and violence was not done to the nomenclature of the specialized groups.

The dates of departure of the various groups of plants were left for the consideration of special committees for each of the special groups. At the mycological section on nomenclature it was voted that the whole matter be thoroughly studied in order to obtain more satisfactory dates of departure since there was considerable dissatisfaction with the present dates. It is hoped that this committee¹ will act with promptness but not undue haste in determining the date of departure whether for each major group of fungi or for the fungi as a whole.

The proposal that Friesian subgenera of *Agaricus* be recognized as genera, with Fries as the authority, although receiving some support because of the ease and simplicity of settling the question in this way, nevertheless was rejected on the ground that it was unscientific, inaccurate, and led to carelessness in citation. This question was therefore turned over for consideration to the same committee that is to handle the problem of the dates of departure.

The principle of usage in the choice of type species to represent genera was strongly opposed since it was felt that usage in different countries varied greatly and hence that method

¹ Ramsbottom, J., England; Maire, R., France; Shear, C. L., United States (Chairman); Wakefield, E. M., England; Pilat, A., Czechoslovakia; Seaver, F. J., United States; Boedijn, K. B., Holland and Java; Nannfeldt, J. A., Sweden; Ciferri, R., Italy; Trotter, A., Italy; Weston, W. H. Jr., United States; Lutjeharms, W. J., Holland.

could not help in stabilizing nomenclature. Therefore this subject was also referred to the committee on mycological nomenclature.

The conditions for the effective publication of names has been somewhat amplified by the statement to the effect that when separates appear in advance of books or publications, the date of the name starts from the date of publication of the separate. It was made clear that the date must be definitely indicated in print on the reprint. At the same time the separates should be sent to each of the selected institutions which have been provisionally listed. The list of institutions however, was found to be far too poorly representative of the various countries and the opinion was that the number of institutions be increased and that botanical societies and institutions be invited to coöperate in naming the additional herbaria and libraries.

Citation of misdeterminations in literature came up for considerable discussion which ended in a recommendation to the effect that the manner of citing such misdeterminations be left to the discretion or preference of the individual, but however cited, the misdeterminations must be kept separate and distinct from the actual synonymy of the species.

One of the most important discussions centered around article 54. The proposal B54 reads as follows: "When on transference to another genus the specific epithet has been applied erroneously in its new position to a different species, the new combination must be retained for the plant on which the epithet was originally based and must be attributed to the author who first published it." This article unfortunately was passed in spite of the fact that it does violence to the type concept and is more than likely to increase confusion and perpetuate errors unless *the original type specimen or description is consulted and not that upon which the new combination was made*. The one advantage, hardly scientific in point of view is that it simplifies the task of keeping indices. The alternative proposal A54 reads as follows: "When on transference to another genus, the specific epithet has been applied erroneously in its new position to a different plant, the combination must be retained for the plant on which the epithet was originally based and must be attributed to the author who

first correctly used the combination for the right plant. The incorrect use must not be treated as an earlier homonym." In view of the fact that the type method has been accepted by all but a few die-hards and since article A54 is the only logical outcome of the method, it is greatly to be hoped that article 54 as at present accepted be reconsidered before too great harm results.

As a check on careless work and premature publication, it was the definite opinion of the majority of delegates that the publication of eventual names be suppressed, and to this end it was ruled that only the first of two or more names for a single species when published at the same time, be taken into consideration. For example, as the writers understand the ruling, if an author publishes a new name and is not sure as to the generic position of the species and he simultaneously publishes the species under two generic names, then only the first name need be considered and subsequent investigators may or may not accept the other name should it later be shown that it is more appropriate. In other words, it is felt that a species cannot be in two genera at the same time.—D. H. LINDER, F. J. SEAVER.

SCHIZOPARME STRAMINEA AND NECTRIELLA Versoniana
IDENTICAL

A reprint of a paper "A dry rot of pomegranate fruit caused by *Zythia Versoniana* Sacc.," by F. L. Tai and C. C. Cheo, has been received recently from Prof. Tai, now of the Institute of Agricultural Research, Tsing Hua University, Peiping, China. The authors state that the losses due to this fungus may be from thirty to forty-nine per cent for some varieties. They also note that T. F. Yu, under the title "Notes on the storage and market diseases of fruits," Jour. Agr. Assoc. of China 123: 16-27, 1934, reports having observed a serious storage disease caused by this same fungus.

Some years ago, the writer, in coöperation with the Office of Fruit Diseases Investigations, U. S. Department of Agriculture, began working at odd times on rots of strawberries found in the markets of New York City. A fruit rot first picked up in 1918 was not found especially destructive, but the fungus causing it

was very interesting. Pure cultures were obtained and sound strawberries were inoculated to prove that the characteristic rot was caused by this particular fungus.

The rather dark greenish or olivaceous pycnidia that developed on the fruit were densely crowded together. They could be readily distinguished from fruit bodies of other fungi common on strawberries by the mass of light-colored tissue which surmounted the pycnidium in each case. This overgrowth resembled a little crown surrounding the ostiole. Although the wall of the mature pycnidium was somewhat carbonaceous, suggesting a *Phoma* type, the fleshy appearance, due to the crown of sterile tissue, would lead one to place the fungus in *Zythia*. In July 1920, some perithecia associated with the same kind of pycnidia originally found on rotting strawberries were found on strawberry leaves. The connection between the pycnidial and perithecial forms was established culturally. The ascospores germinated readily even before they were discharged from the ascus. Asci still containing spores were floated out from crushed perithecia so that they could be isolated. The eight spores included in an ascus were transferred together with the hope that if the species were heterothallic one might obtain perithecia with greater certainty. About 100 "single ascus" cultures were obtained, but in no case were perithecia developed. On the other hand large numbers of pycnidia matured, and spores from these were used to inoculate strawberry fruits. There was no question that the two fruiting stages belonged to the same fungus.

The formation of the central cavity in the pycnidium, the growth of the buffer tissue, the formation of the ostiole and other features were studied. Parallel studies were also made of the perithecial fruit bodies found on leaves of strawberries, roses and various other plants. A most interesting series of parallelisms could be followed. These features were described and illustrated by the writer under the title—"Origin of the central and ostiolar cavities in pycnidia of certain fungous parasites of fruits" (Jour. Agr. Res. 23: 743-760, fig. 1, pls. 1-6. 1923). As the writer was anxious for a specific name to which the fungus could be referred in this paper, it had been submitted to Dr. C. L. Shear

for identification. As he was unable to determine the species from any description which we could find in the literature, he described it as new and made a new genus *Schizoparme* based on this species, and called it *Schizoparme straminea* (Shear, C. L. Life histories and undescribed genera and species of fungi. *Mycologia* 15: 120-131. 1923).

Reading the description of the fungus causing the dry rot of pomegranate as given by Tai and Cheo, and comparing their description and figures in their plates 2 and 3 with those given by Shear, and with those accompanying the article by the writer, and referred to above, one must be fully convinced that *Nectriella Versoniana* Sacc. & Penz. (*Michelia* 2: 256. 1881) and *Schizoparme straminea* Shear are one and the same fungus. As further evidence on the question one need only to compare the specimen in Saccardo's *Myc. Ven.*, 1484, *Nectriella Versoniana* Sacc. & Penz., with specimens of *Schizoparme straminea* Shear in the Mycological Herbarium in Washington. Or one can readily obtain the fungus from strawberries in the markets of New York City, if he examines shipments arriving from Florida in late winter. The pycnidial stage *Phoma (Phomopsis) Versoniana* Sacc. (*Michelia* 2: 272. 1881), was later transferred to *Zythia* (Sacc. *Syll.* 3: 614. 1884).

Tai and Cheo state that the fungus tends to become zonate in culture and that the pycnidia are often crowded together. These features were also brought out in our own illustrations. Tai and Cheo figure several asci showing the two small very characteristic bodies, "favolae," at the upper end of the ascus. In the original description by Saccardo and Penzig (*Michelia* 2: 256) this feature is also mentioned. My own cytological preparations show these bodies (ascostome collars?) very distinctly.

When the pycnidium develops on strawberry fruits or on leaves, the stromatic tissue is not very evident and the pycnidial cavity is largely schizogenetic. The buffer tissue develops as a "circumostiolar epistroma," as Shear calls it, a very interesting and characteristic feature.

Macrophoma Granati (Sacc.) Berl. & Vogl. as described and illustrated by Bubak (*Bull. Herb. Bois.* II. 6: 475, pl. 15, figs. 5-8) is clearly the same thing. His figure 5 shows exactly what we

find in sections of the pycnidia on strawberry or on leaves of *Rhus*. Bubak's plates 14 and 15 are transposed as can be seen from the legends. In view of the world wide distribution of the fungus and the fact that we have found it on species of such distantly related genera as *Eucalyptus*, *Vitis*, *Rhus*, *Fragaria* and *Salix*, it is very probable that the fungus has been described under several other names. Examination of Saccardo's M. V. 514 would no doubt prove that *Phoma Granati* Sacc. (N. Gior. Bot. Ital. 8: 200. 1876) and *Phoma Versonian* are synonymous; if so the specific name *Granati* logically should take precedence over *Versoniana*. I am informed that the present International Botanical Rules require that the first specific name applied to the perfect or ascocarpic stage must be used. By what sort of reasoning such a rule can be defended is beyond our comprehension.

After the above note was in type Dr. D. H. Linder kindly compared specimens of *Phoma Granati*, M. V. 514, and *P. Versoniana*, M. V. 1484, in the Herbarium of Cryptogamic Botany, Harvard University. It is his opinion that they are identical. He expresses some doubt, however, that *Phoma Granati* is connected with the *Nectriella*. He was unable to find ascospores of the *Nectriella* in either specimen. The specimen of No. 1484 in our collection at The New York Botanical Garden does show characteristic asci of the *Nectriella*.—B. O. DODGE.

THE MYCOLOGICAL SOCIETY OF AMERICA

(WITH 2 FIGURES)

SUMMER FORAY

Pursuant to notices of time and place in *Mycologia* and *Science* the Mycological Society of America held a four-day summer meeting at Ithaca, N. Y., beginning on Tuesday morning the 20th of August, 1935. It was the third of such summer meetings or forays held since the organization of the Society in 1931. The first took place in North Carolina with headquarters at the Highlands Biological Laboratories and Museum, the next at the summer camp of Professor F. C. Stewart on Seventh Lake in the

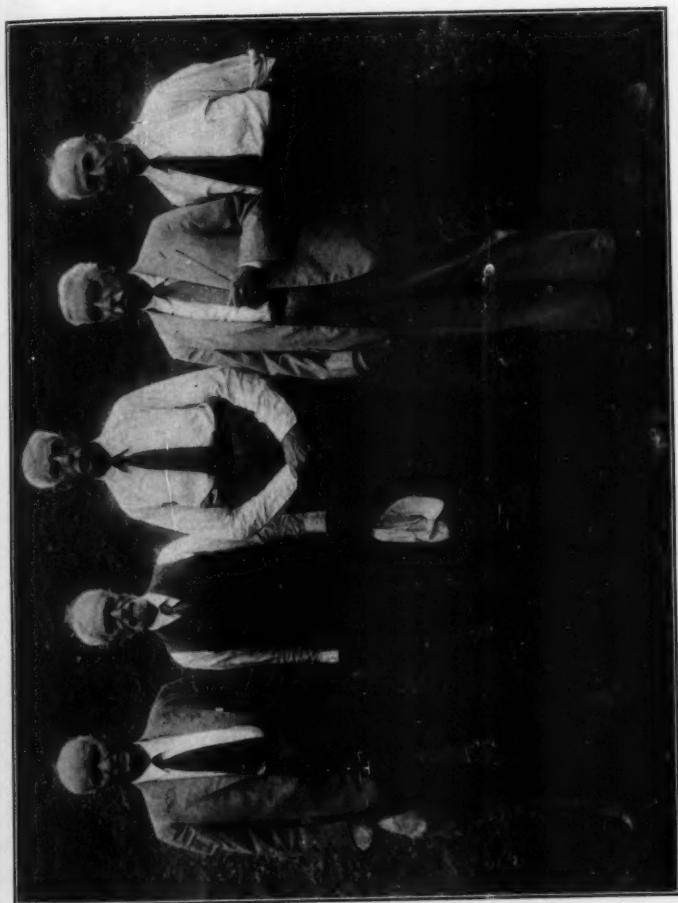


FIG. 1. SUMMER FORAY—1935. H. C. Beardslee, John Dearness, F. C. Stewart,
J. C. Arthur, E. A. Bessey.

Adirondack Mountains in northern New York. This year headquarters were established in the convenient and well equipped laboratories of the Plant Science Building of Cornell University. Thus far these Forays have combined the pleasure of a summer holiday and the benefits of social intercourse among people of similar interests, with the advancement of knowledge of their favorite science.

Perfect weather during the whole week of this meeting favored traveling to and from the meeting place as well as the carrying out of the definite day-by-day program. Cars started every morning at eight or nine o'clock to convey members to designated collecting fields, returning at noon. The afternoons were devoted to investigating at the laboratories with microscopes, library facilities, and other necessary equipment, the amply sufficient quantity of material collected. Electrically operated driers for the studied and identified "fleshies" were kept running day and night.

Tuesday evening an informal reception for the visiting mycologists and their families was given by the staff members, graduate students, and wives of the Department of Plant Pathology. Additional guests included the members of other departments of the large biological group at Cornell. Wednesday evening was set aside for the making of mycological demonstrations of general interest. President B. O. Dodge discussed certain aspects of his research on *Neurospora*, and illustrated with photographs, cultures, and slides the points emphasized. Mr. Robert Hagelstein displayed an attractively mounted collection of the Myxomycetes of New York State, which included specimens of practically all North American genera and species.

If there are any better collecting fields than in the district around Ithaca they must be very rare; nothing is lacking in the completeness and convenience of the laboratory equipment for botanical work in the Plant Science Building of Cornell University; there was no lack of sympathy, even of generosity, on the part of the University authorities, and yet with all these favorable factors the Foray could not have been such a success without the preparatory and continued efforts of Professors Whetzel and Fitzpatrick who composed the local committee on arrangements.

They knew the resources well and possessed the knowledge, will, and skill to make success complete.

Contributing to the pleasure of visiting members' wives who were not especially interested in fungi was a social program in which the homes of the local professors were opened for entertainment. On Thursday evening all members of the Foray went to Taughannock Falls State Park, a beautiful reservation on Cayuga Lake, for a picnic supper. Brief addresses were given by President Dodge, Doctor Arthur, and others. At the Friday afternoon recess for "a cup of tea" the Secretary was instructed to convey to the Head of the Department of Plant Pathology, the Dean of the College of Agriculture and the President of Cornell University the cordial thanks of the members of the Foray for the hospitality of the University.

During the month preceding the meeting, rainfall in the vicinity of Ithaca had been below normal. Still the collecting in most groups was satisfactory and in some was excellent. Though the mycological interests of members of the Foray were various, perhaps the greatest number gave attention to the fleshy fungi. The following list has been compiled by Professor Fitzpatrick from data provided by various individuals and received in time for this report. It contains the names of those species which for one reason or another attracted attention.

NOTEWORTHY COLLECTIONS

MYXOMYCETES: *Lamproderma muscorum* (Lév.) Hagelstein, *Comatricha Rispaudii* Hagelstein, *Clastoderma Debaryanum* Blytt, *Kleistobolus pusillus* Lipp., *Licea biforis* Morg., *Physarum leucopus* Link, and *P. penetrans* Rex.

About 600 distinct fruitings were collected by Robert Hagelstein and Joseph H. Rispaud. These represented 32 genera, 119 species, and 7 varieties.

ASCOMYCETES: *Endogone macrocarpa* Tul., coll. Whetzel; *Sphaerospora brunnea* (Alb. & Schw.) Masee, coll. Conners; *Gorgoniceps* n. sp., coll. Dearness; *Texiffigia Corni* (Auersw.) Toro, coll. Dearness; *Baeomyces roseus* Pers., coll. Dearness; *Spathularia velutipes* Cooke & Farl., coll. Viégas; *Gloeoglossum*

affine Durand, coll. Conners; *Cordyceps ophioglossoides* (Ehrh.) Link, on *Elaphomyces granulatus* Fr., coll. Welch; *Hypomyces hyalinus* (Schw.) E. & E., coll. Dearness.

FUNGI IMPERFECTI: *Hainesia Lythri* (Desm.) v. Höhn. on *Steironema ciliatum* (L.) Raf., coll. Conners; *Stephanoma strigosum* Wallr. on *Lachnea hemisphaerica* (Wigg.) Gill., coll. Conners; *Cylindrosporium acerinum* Peck on *Acer spicatum* Lam., coll. Dearness.

UREDINALES: *Puccinia tenuis* (Schw.) Burr. on *Eupatorium urticaefolium* Reich., coll. Conners; *P. recedens* Syd. on *Senecio aureus* L., coll. Arthur and Kern; *Pucciniastrum Myrtilli* (Schum.) Arth. on *Vaccinium pennsylvanicum* Lam., coll. Dearness.

AGARICACEAE: *Collybia dryophila* Fr. with convoluted excrescences (*Tremella mycetophila* Peck) on pileus and stem; *Lactarius vellereus* Fr., bearing similar excrescences on the pileus, coll. Stewart; *Cantharellus floccosus* Schw., coll. Dearness; *Lactaria Indigo* Schw., *L. chrysorhea* Fr., *L. atroviridis* Peck (These three species regarded by Miss Burlingham as outstanding among the 35 species of *Lactaria* and *Russula* collected by her.); *Entoloma cuspidatum* Peck, *E. luteum* Peck, *E. salmoneum* Peck, *Cortinarius bolaris* Fr., *C. lilacinus* Peck, coll. Beardslee.

POLYPORACEAE: *Polyporus Berkeleyi* Fr. coll. Burnham; *Polyporus Montagnei* Fr., coll. Viégas; *P. flavovirens* Berk. & Rav., coll. H. A. C. Jackson; *Boletus* n. sp.? (This species lying near *B. chrysenteron* and *B. fumosipes*, regarded as the most interesting of 24 species of this genus collected by Snell); *Boletinus pictus* Peck, coll. Stewart; *Poria eupora* Karst., coll. Lisi.

HYDNACEAE: *Hydnum fennicum* Karst., *Hydnellum velutinum* Fr. *H. humidum* Banker, *H. scrobiculatum* Fr., *H. zonatum* (Batsch) Karst., *Phellodon albo-niger* (Peck) Banker, *P. velereus* (Peck) Banker (all collected by Beardslee); *Hydnum imbricatum* L. coll. Dearness.

BASIDIOMYCETES (Miscellaneous): *Eocronartium muscicola* (Pers.) Fitzp., coll. Dearness; *Sebacina incrustans* (Pers.) Tul., coll. Lisi; *Tremellodendron pallidum* (Schw.) Burt, coll. H. A. C. Jackson; *Hypochnus botryoides* (Schw.) Burt, *H. fumosus* Fr., coll. Lisi; *Clavaria amethystina* (Batt.) Bull.—JOHN DEARNESS.

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